WASHINGTON, D. C.
1911

AMERICAN BREEDERS MAGAZINE

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A JOURNAL OF GENETICS

Supposed Inferiority of First and Second Born Members of Families
T. B. MACAULEY

Horses and Horse Breeding
H. K. BUSH-BROWN

Separating Heredity from Environment
F. ADAMS WOODS

Laboratory Exercises in Plant Breeding
ARTHUR W. GILBERT

Third Quarter | July, Aug., Sept.

Vol. II | No. 3

Entered as second-class matter June 10, 1910, at the Post Office at Washington, D. C., under the Act of July 16, 1894

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Address Communications to American Breeders Association, Washington, D. C.

Membership: Annual, $2.00; Life, $20.00; Patrons, $1,000.

THE AMERICAN BREEDERS MAGAZINE

Published Quarterly by the American Breeders Association

FOR THE USE OF ITS MEMBERS

PRICE OF SINGLE COPIES, 35 CENTS

Address communications to American Breeders Association, Washington, D. C.

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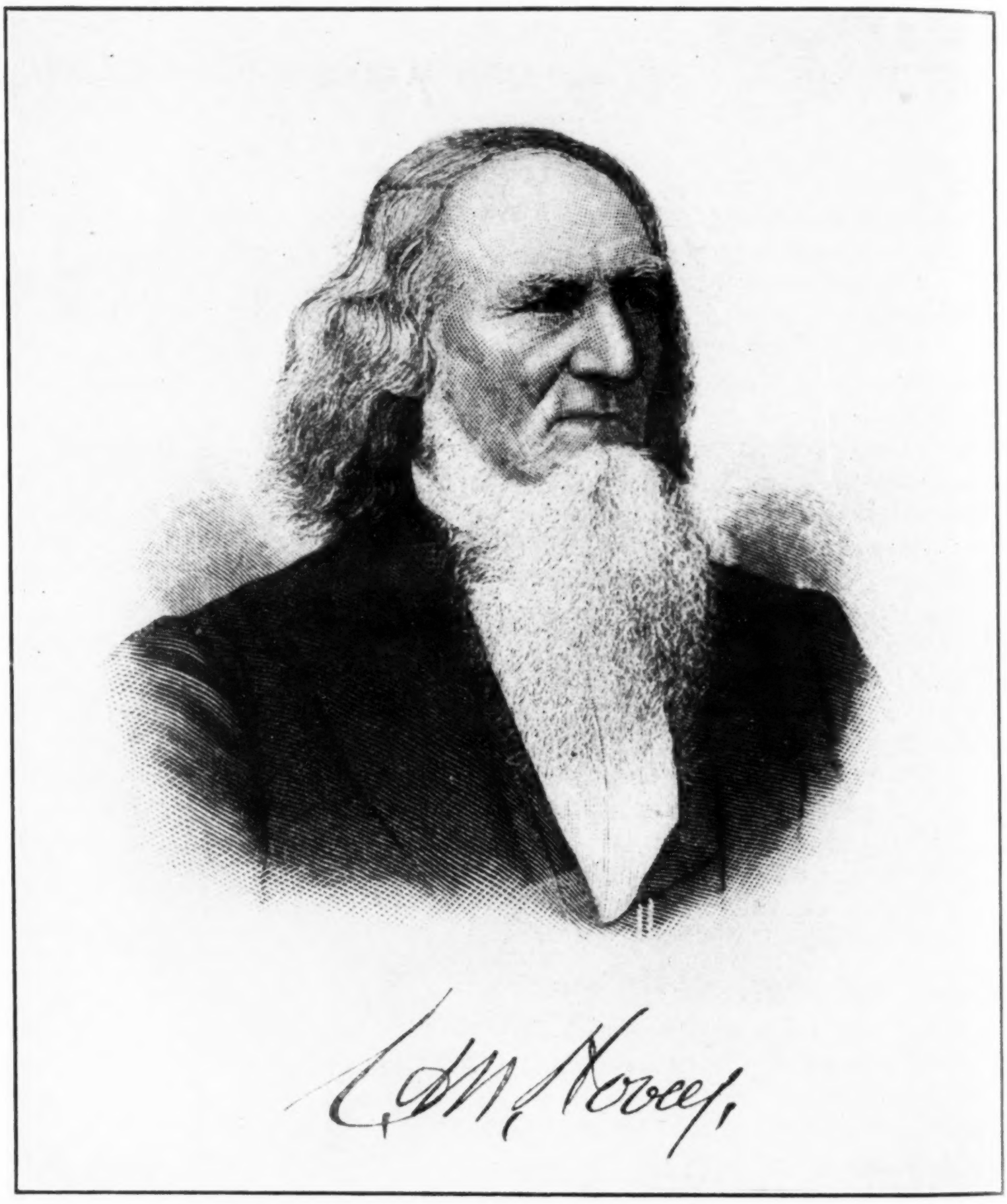


THE AMERICAN BREEDERS MAGAZINE

"Seed is the beginning of all wealth."—W. R. Smith.

Vol. II | Third Quarter, 1911 | No. 3

CHARLES MASON HOVEY, 1810-1887

The domestication of plants and animals was man's first decided interference with nature's usually automatic regulation of her affairs —an assertion of man's personality, and a proclamation of man's mastership.

One of the remarkable incidents connected with the fact of the domestication of plants is that apparently unpromising or almost negligible characters often caught the breeder's eye. He developed them to an unusual degree, first by cultivation, then by selection and breeding. The unobtrusive wild strawberry is a case in point, and the man with the eye of genius who saw possibilities in the edible, small red berry, and who had in his mind the method and in his hands the skill to bring about a most wonderful change in shape, size, and in the shipping and keeping quality of the strawberry was Charles Mason Hovey.

Long perhaps after minor incidents of his active and useful career shall be forgotten Mr. Hovey, who was born in Cambridge, Mass., in 1810, will be known as the "father of the American strawberry." He bred and propagated a large number of varieties of fruits and flowers, shrubs and vines, some of these of great merit. The *Thuja hoveyi*, a form of arbor vitæ, has a place in the heart of every lover of evergreens. But his largest offering, his *chef d'œuvre*, was a strawberry which made possible the development of all our present American commercial varieties.

Up to Hovey's time the common wild strawberry and its cultivated descendants furnished the tables direct from the garden, but of commercial varieties there were none.

The origin of Hovey's basic variety cannot be intelligently discussed without going somewhat into the history of the domestication of the strawberry. And fortunately Dean Bailey of Cornell has discovered the clue to this history in his study of the garden varieties of the strawberry. Previous to the time when Bailey assigned a definite, specific place to our cultivated strawberry and recognized

it as *Fragaria chiloensis*, it was treated as a sort of stepchild by botanists and had no place or name in particular which would indicate either its origin or botanical position.

The fact that scientific study had to disclose its real origin after it had been in cultivation for almost two hundred and fifty years adds strength to the often repeated statement that the origin and domestication of most of our cultivated plants are veiled in doubt and mystery.

Fragaria chiloensis, a strawberry plant originating in Chili but known to be common to western North and South America, had been brought to Europe about 1712. Forty years of cultivation and use had developed nothing of outstanding value. Then, somewhere, suddenly a mutation, possibly a hybrid, which was an improvement on this parent, seems to have arisen and found distribution as the "Pine Strawberry" from its flavor resembling that of the pineapple. Hovey crossed the native American strawberry with imported plants of this "Pine" variety and obtained a large number of crosses from which he fruited two varieties of especial promise which he named Hovey and Boston Pine. The Hovey was the first pistillate strawberry placed before the American public. It gave strawberry breeding a wonderful impetus and hybridizers began to put out new varieties.

And as early as 1830 he had a list of 30 strawberries of his own origination, all springing from the Hovey, and in fact practically all commercial varieties sprung from this one original parent variety. In 1836 the Hovey was distributed commercially and for thirty years in succession this variety took first premium over all other varieties at the exhibitions of the Massachusetts State Horticultural Society. Among all his varieties the originator held it in high esteem.

Hovey was versatile, resourceful, and possessed of apparently inexhaustible enthusiasm. He was successful as author, editor, plant breeder, nurseryman, and merchant. He contributed voluminously to horticultural literature, and in 1835 established a journal under the name of *American Gardener's Magazine*, which was subsequently changed to *Hovey's Magazine of Horticulture*, which continued during thirty-four years. He entered upon the publication of a pretentious and elaborate illustrated work, named "Fruits of America," of which two volumes were published.

Mr. Hovey was elected president of the Massachusetts Horticultural Society and vigorously promoted the interests of that institution. During his term of office its membership was increased from

500 to 1,000. His efforts were largely responsible for the erection of a beautiful building for the society's use. He was an inveterate collector of varieties. On his experimental grounds he had at one time 1,000 varieties of pears, 100 of apples, and 50 of plums, and at one time he showed 200 varieties of camellias.

THE SUPPOSED INFERIORITY OF FIRST AND SECOND BORN MEMBERS OF FAMILIES: STATISTICAL FALLACIES

T. B. MacCauley
Montreal, Canada

There is a general impression that while the study of eugenics may be interesting it can be of but little practical value owing to numerous and obvious difficulties in applying to the improvement of the human race the principles and methods which can be used in animal and plant breeding. Students of the science, while frankly recognizing this difficulty, have endeavored, nevertheless, to make their investigations as practical and helpful as possible. It has been thought by some that a foothold for practical work has been found in the supposed fact of the inferiority of the early born members of families, which certain authorities have claimed to have discovered and proved. If later born children are, on the average, superior to their elder brothers and sisters, then all influences which tend to increase the size of families have not merely a numerical effect on the population, but also an effect in preventing degeneration and improving the quality of the race. Several other important conclusions have also been drawn from this supposed fact. It is therefore desirable to investigate carefully the foundations on which the theory is based. Is it really a fact that early born children are, as groups, usually inferior to the later born of the same families? Let us examine some of the statistics which are relied upon as proof.

I have before me Dr. Karl Pearson's "First Study of the Statistics of Pulmonary Tuberculosis." It contains an analysis of the records of 381 families, with 2,164 members, each family having one member in the Crossley Sanatorium.

Tuberculous families, numbers of each class of sibling.

Order of siblings.	Number of cases.	Order of siblings.	Number of cases.
1	381	12	15
2	366	13	9
3	332	14	6
4	289	15	2
5	247	16	1
6	185	17	1
7	126	18	1
8	86	19	1
9	57	20	1
10	35	21	1
11	21	22	1

The tuberculous patients from these families were distributed as follows:

Tuberculous patients

Number of siblings.	Number of cases observed.	Number of cases calculated.	Per cent observed of calculated.	Number of siblings.	Number of cases observed.	Number of cases calculated.	Per cent observed of calculated.
1	113	67.1	168.4	8	9	15.1	59.6
2	79	64.4	122.6	9	3	10.0	30.0
3	41	58.5	70.0	10	3	6.2	48.4
4	52	50.9	102.1	11	3	3.7	
5	39	43.5	89.6	12	1	2.6	
6	18	32.6	55.2	13	1	1.6	56.6
7	18	22.2	81.1	14	1	1.1	
				above 14	0	1.6	

Dr. Pearson says:

If we consider the community as a whole, it will be built up of families in all stages of development. There will be some in which both eldest and youngest siblings have passed through the tuberculous zone, some in which the eldest have and the youngest have not, and some in which the eldest are in it and the youngest have not reached it. Each one in his lifetime passes through the danger zone, and we might expect, out of the totals that pass through, the same percentage would be attacked, whether they happen to be elder or younger siblings. In other words, if we take the Crossley Sanitarium population at a given date, we might expect that as far as position in family is concerned it would be drawn indifferently from all parts of the family.

Dr. Pearson accordingly finds the ratio of the 381 patients to the 2,164 members of the families to which they belonged, and, applying that ratio to the number of children of each order of birth, tells us that the resulting calculated numbers as given above are the numbers that should have been in the sanatorium if the liability to tuberculosis

were equally great in all members of each family, regardless of their order of birth. (See above table.) The actual numbers of inmates, it will be seen, are, among the early births, greatly in excess of the supposed normal numbers as calculated by Dr. Pearson, and are less than the numbers calculated for the later births.

Dr. Pearson further presents a diagram which vividly illustrates the supposed greater liability to tuberculosis of the early born, and the supposed comparative immunity of the later born, and adds: "It will be obvious on mere inspection of this table, or of the accompanying graph, that the excess of elder born, and defect of younger born, is most marked."

Dr. Pearson's conclusion is:

> In general, whether we deal with all tuberculous stocks, or only with those having no parental history, the elder offspring, especially the first and second, appear subject to tuberculosis at a very much higher rate than the younger members. If this special incidence on the earlier born be found to be true for other forms of pathological heritage, we have a very serious factor of national deterioration introduced by the growing limitation of the family. It is further conceivable that any class which reproduces itself largely from the elder children, e.g., the peerage, as far as the father is concerned, would tend on the average to degenerate more rapidly. The substantiation in other cases of this pathological weighting of elder children, which appears true for the cases of tuberculosis and insanity, would be a eugenic fact of the greatest importance. The limitations of the family may not only be an evil, if it leads to a smaller relative output of the mentally and physically better stocks, but, even in the case of feebler stock, it may lead to a relatively larger proportion of the more affected individuals being added to the community.

In his pamphlet on "The Problem of Practical Eugenics," Dr. Pearson reproduces the diagram above mentioned, and adds other similar diagrams, showing the supposed greater liability to insanity, crime, albinism, among the earlier born. He adds:

> If our observations are correct, and I believe them to be so, then the mental and physical condition of the first and second born members of a family is differentiated from that of later members. They are of a more nervous and less stable constitution. We find that the neurotic, the insane, the tuberculous, and the albinotic are more frequent among the elder born. Dr. Goring's results from criminality show the same law. The diagrams I put before you bring this out; you see in the tuberculous, the insane, and criminal stocks that the first few members are weighted. But the result of this law is remarkable. It means that if you reduce the size of the family, you will tend to decrease the relative proportion of the mentally and physically sound in the community. You will not upset this conclusion in the least, if, as I suspect, the extraordinarily able man, the genius, is also among the early born. For you will not lose him if you have a larger family, although you will lose the sounder members if you curtail it.

From these supposed facts the professor draws some very far-reaching conclusions, even claiming that they require a modification of the Mendelian theory. He says:

> It is difficult to reconcile this result with any simple Mendelian theory; it would seem necessary to combine such a theory with what amounts in result to a selective action on the gametes. I have already pointed out that such action would not only modify the Mendelian proportions, but also the parental co-relations. Further, this selective action would vary with the environment, *i.e.*, the changing constitution of the parents. Such direct action of the environment on the gametic cells is one which it would from the standpoint of national eugenics be of the greatest importance to study.

These arguments are certainly plausible, and the conclusions derived thereform are at least interesting. Before, however, we follow the professor in considering these embellishments or upper stories, so to speak, of the great structure which he has erected, let us examine the foundation stones more carefully. Unless the foundation be solid, the building collapses.

Let us consider first the statistics of tuberculosis. It is perfectly clear that the sanatorium contained larger proportionate numbers of early born patients than of later born of the 381 families. Does this, however, prove that early born children are more liable to the disease than later born? Not at all. Such a condition as that shown by Dr. Pearson's statistics was inevitable, and could have been foretold. Suppose, for instance, that of the 381 families included in the statistics, one consisted of fifteen children, the eldest twenty years of age, the youngest six months. The eldest had developed tuberculosis, and entered the sanatorium. All the fourteen younger brothers and sisters would be carefully tabulated and included in the numbers of tuberculous stocks of the later born. Because fewer of such later born and therefore young siblings, babies, perhaps, had become inmates of the sanatorium, we are asked to accept that fact as proof that later born children are superior to their elder brothers and sisters. It may be claimed that a family of fifteen is an extreme supposition, but the statistics before us include not only a family of fifteen children, but one of twenty-two. It is not wonderful, however, that the statistics also show that at least the youngest eight of that family (all of the eight being probably very young children, some of them possibly infants) were not inmates of the sanatorium, there being no inmates belonging to any group beyond the fourteenth born.

Dr. Pearson tells us, however, that "while a certain number of families exist with young siblings in which the older alone are likely to suffer, there are others in which the older are dead, or past the danger zone, and in which only the younger are likely to suffer," and he makes the assumption, therefore, that there will be enough older members of families whom he considers to be dead or past a supposed "danger zone" to offset the younger siblings. Unless this assumption be substantiated, that there is a special danger zone, and enough members of the families beyond it to offset the younger siblings, the foundation of the whole theory and of all its developments is removed, and the entire structure collapses like a house of cards. When the vital importance of this assumption is thus realized, we would expect that some proof would have been produced in support of it, but there is nothing, absolutely nothing. The foundation is simply *assumed* to be there, and a great edifice is then endeavored to be built on it. To those who think the assumption is sound, we commend the following statistics from the report of the Registrar General of England and Wales, 1891–1900:

Annual mortality from phthisis per million living at various ages.

Age.	Mortality per million	Age.	Mortality per million.
0 to 4	413	35 to 44	2592
5 to 9	206	45 to 54	2362
10 to 14	368	55 to 64	1881
15 to 19	1144	65 to 74	1154
20 to 24	1730	75 and over	437
25 to 34	2135	All ages	1391

In the face of such figures it is difficult to see how the claim can be supported that the older members are "past the danger zone," and therefore not likely to become inmates of a sanatorium. Not until age 75 does the death rate from phthisis descend to the neighborhood of what it is below age 15. The professor claims that the mean age of onset of the disease is 29.1 for males and 25.3 for females. That, however, is merely another way of saying that at those average ages the patients *began* to be eligible for admission to the sanatorium. Patients may be admitted not merely at the onset of the disease, but probably at any time prior to death. Not merely, therefore, is the assumption which we are asked to accept entirely unproved, but in view of such statistics as the above, would appear to be entirely disproved.

To sum up: In Dr. Pearson's tables the inclusion of children and babies who are not yet old enough to be exposed to the dangers in question very clearly makes it inevitable that the groups of later born, to which these children belong, will show a more favorable percentage than the groups of early born, who are of necessity grown up. To draw any serious deductions from such statistics would on its face appear absurd. Dr. Pearson, however, contends that there are as many people dead, or who have passed the supposed danger zone, as there are children in the families not yet old enough to be exposed. This may be so, or may not be so. It is a tremendous assumption to make, and he does not bring an atom of proof in support of it. So far from being reasonable and credible, it appears to be in direct conflict with the statistics of the disease. Until the Doctor can show that there is a better foundation under his theories, he must not expect them to be taken seriously.

The diagrams produced in regard to insanity and crime are, as already mentioned, similar to that relating to tuberculosis. I have not before me the statistics upon which they are based, but there is little doubt that they have been prepared in precisely the same manner. If so, the inclusion of young children among the later births renders these results also valueless. The later born groups, which include a considerable number of children, naturally have not developed as large a proportion of insane persons and criminals as the older adult members of their families, but Dr. Pearson's contention that this proves that those later born individuals are to that extent superior to the older born is not even open for serious discussion. It cannot even be claimed that there is a danger zone in insanity and crime, such as was claimed for tuberculosis. The older siblings have in reality had just so much longer time to develop insanity or criminal propensities than the younger ones.

Apart altogether, however, from the effect of including in the statistics the undeveloped members of the families, another consideration, not, however, probably productive of as marked an effect on the statistics, would lead us to expect that the early born groups would show higher percentages of individuals lacking in robustness, or even given to crime. If one or other or both parents die, for example, of consumption at comparatively early ages, their average family will certainly be much smaller than in the case of couples neither of whom die prematurely. Parents of criminal or semi-criminal tendencies, moreover, may not remain together sufficiently long in the marriage state to have large families, though on the other hand some paupers

and others may have families over the average. The children of these small tuberculous or criminal families would of course all fall into the earlier born groups, and as a result of heredity we would expect somewhat larger percentages of weak or criminal children in those groups. That, however, in no way indicates that early born children are inferior to later born *of the same family*.

We now, however, come to another remarkable supposed fact which Dr. Pearson claims to have proved. He states that families containing tuberculous members are, on the average, larger than those of the total population. He makes a similar claim with regard to several other types of inferiority. Is this contention well founded, or is it like the one we have been previously discussing, a mere statistical fallacy which will not bear investigation?

I quote again from Dr. Pearson's study of the statistics of tuberculosis:

> The distribution of the 381 tuberculous families, which may be practically considered as completed, is as follows:

Size of family.	Number of families.	Size of family.	Number of families.
1	15	9	22
2	34	10	14
3	43	11	6
4	42	12	6
5	62	13	3
6	59	14	4
7	40	15	1
8	29	22	1
			Total....381

> Accordingly the mean family contains 5.80, and for the female pedigrees 5.59. Mr. Schuster finds the mean size of families containing at least one deaf mute to be from American statistics 6.08, and from English statistics for probably completed families 6.19.
>
> It would thus appear that fewer offspring are not born to stocks tainted with pulmonary tuberculosis.
>
> There is no reduced fertility in the case of tuberculosis; in fact their fertility is as great as that of any other class in the community.

The professor compares the result obtained as above with the average size of families in the community as a whole, and claims that these statistics show that "the families of the affected are larger, not smaller, than those of normals."

Do these figures really prove that the tuberculous families of the community are on the average as large as, or larger than those of normal

stocks? Most decidedly not. The mean family, as given, represents the mean for those particular 381 families, but it does not, and cannot, represent the average size of tuberculous families in the community as a whole. It is in fact impossible to ascertain the average size of a family in this manner. Statistics compiled in this way must always, and inevitably, overstate the average. Dr. Pearson treats these 381 families as though they were indifferently chosen from the tuberculous families of the community, but this is not so. Such a selection is one of children, not of marriages or of families, and the probability of any one marriage being represented in the sanatorium is in direct proportion to the number of living children in the family. Marriages with a large number of children are very likely to be included; marriages with but few children are correspondingly less likely; while childless marriages will not be represented at all. A marriage with ten children has ten times as great a chance of being included in the statistics as a marriage with but one child. A marriage with twenty-two children, like the one mentioned in Dr. Pearson's statistics, has twenty-two times the chance of being included that a marriage with but one child has, for there are twenty-two children who may develop tuberculosis as against one in the other case. The mean family derived from statistics so compiled clearly does not, and cannot, represent the average of the tuberculous families of the country, and to compare a result so found with the average size of a family in the community as a whole is simply to deceive ourselves.

Perhaps we will better appreciate the nature of these fallacies if we apply the same rules and reasoning by which they are produced to a supposititious case. Let us imagine a community which contains 1,000 families of one child each, and 1,000 other families with ten children each. These 11,000 children in the 2,000 families give an average family of course of exactly 5.5. To simplify the problem, let us assume that the 10,000 children of the families of ten are so evenly distributed that there are precisely the same number of first born children living at every age, from twenty to forty-four inclusive, and that the ages of the children of the same families are precisely two years apart. This is a purely artificial grouping, but its very simplicity will help us to understand better the principles involved. It is, of course, quite proper for us to ignore families of which no member has reached maturity, just as such families find but little place in the records of a sanatorium for pulmonary tuberculosis. The 1,000 members of the families of one child are, we will say for convenience, divided evenly from ages 20 to 49, inclusive, there being forty living at each age.

When these materials are arranged according to order of birth, the following is the result:

Order of siblings.	Age in years.				
	Over 25	20–25	11–19	2–10	Total.
1	1520	480			2000
2	680	240	80		1000
3	600	240	160		1000
4	520	240	240		1000
5	440	240	320		1000
6	360	240	360	40	1000
7	280	240	360	120	1000
8	200	240	360	200	1000
9	120	240	360	280	1000
10	40	240	360	360	1000
Total.....	4760	2640	2600	1000	11000

We will now suppose that of the above group 148, or exactly 2 per cent of the total number of siblings beyond age 20, are college professors, the selection being made from each group in exact proportion to its members living at age 20 or over (I mean no disrespect to our professorial friends in naming this young age, merely desiring to make the statistics correspond somewhat to the facts of tuberculosis). Arranging these professors according to order of birth, and comparing them with the calculated number of cases which we should have if the professors were "drawn indifferently from all parts of the family in proportion to the total number of persons of each birth," we get the following:

Statistics about professors.

Order of siblings.	Number of Professors.		Percentage of actual to expected cases.
	Observed.	Calculated.	
1	40	26.9	148
2	19	13.5	141
3	17	13.5	126
4	15	13.5	111
5	13	13.5	97
6	12	13.5	89
7	11	13.5	82
8	9	13.5	67
9	7	13.5	52
10	5	13.5	37

It will be obvious on mere inspection of this table, or of the accompanying graph, that the excess of elder born, and defect of younger born, is most marked. Testing by the usual process for goodness of fit, we conclude that the probability of such a distribution of older and younger members of a family occurring by random selection, lies between one and two in the ten million trials.

This is a truly wonderful discovery. It is very evident that a much larger proportion of the older born members of families become college professors, and the first born are evidently peculiarly subject to this dread complaint. These statistics when combined with the equally convincing statistics in regard to tuberculosis, insanity, crime, and albinism furnish conclusive evidence that the older born, and particularly the first born, are on the average inferior, physically, mentally, and morally, and that the later born are their decided superiors in these respects.

A further and most interesting and important point is to be noted as to the fertility of professorial stocks. Grouping the professors in our statistics according to size of family, we find that twenty belonged to families of one, and 128 belonged to families of ten. In the 148 families there were thus 1,300 children, the average size of the family being 8.8. This is a surprisingly high figure, and of course enormously greater than that of the general population. It furnishes convincing proof that "the families of the affected are larger, not smaller, than those of normals." The results are, in fact, so striking that we must really conclude that there is some connection between fertility and the tendency to professoritis. The exact nature of that connection, and which is cause, and which is effect, we are not yet able to say, but the fact of a connection is obvious. It is not impossible that by increasing the number of professorships we may be able to bring into operation a force that may effectively combat the tendency towards degeneration in the community resulting from race suicide, for with their large average families the numbers of later born and therefore superior individuals would be greatly increased. These statistics, moreover, confirm the necessity of modifying seriously our conception of the Mendelian theory, as already pointed out in connection with our study of tuberculosis.

My readers may smile at this; but this is precisely the reasoning which we are seriously asked by Dr. Pearson to accept as proof of the theories in connection with eugenics, which we have been discussing.

In conclusion, it will be noted that I do not claim that elder born children may not possibly be inferior, on the average, to later born of the same families. What I do say is that we should not be asked to accept this theory and the far-reaching conclusions based on it without positive and convincing proof. Statistics such as we have been considering are relied on as "proof," but they in reality prove nothing whatever. The proof has still to be produced. We require proofs, not assumptions.

If Dr. Pearson's theory be correct, it should be easy to establish that fact, without relying on fallacies. Exclude from statistics all families with less than say five children; exclude also all children that are too young to have been fully exposed to the risk under consideration; compare the later born with the earlier born of their own families only; make allowance for the fact that in cases where the risk is continuous, or partly continuous, during adult life, a man in middle or old age has had a longer time to develop the trouble than one just reaching manhood; carefully exclude all other sources of error; then give us the results, and we will judge of the truth or otherwise of the theory. It is quite possible that the offspring of immature parents may be less robust than others; but the assertion that the first child born to a couple who marry at age thirty is more likely to be a degenerate than the same child would have been had his parents married ten years earlier and had several children before him will require a lot of proof. Until such proof be furnished, we may be pardoned if we do not take the theory seriously.

HORSES AND HORSE BREEDING

H. K. BUSH-BROWN
Washington, D. C.

[Continued from second quarter.]

If not too presuming, I should like to make another suggestion about mules. By reason of the Celtic pony having no callosities on his hind legs and having the stripe down the back, and other characteristics like the ass, it would not be surprising to find that the progeny produced by reciprocal breeding would be fertile to themselves and perhaps to both parental families. Furthermore, if instead of the African ass, which is the farthest removed in type from the horse, the Dzeggetai, also Kaing or Asiatic ass were used, the chances of getting fertile hybrids would be increased, because the Asiatic ass is much more closely related to the horse than is the African type. Furthermore, he has only five lumbar vertebræ. If fertile mules can be produced, the way is open for a new hybrid species to be developed.

To return, then, to the original proposition: There are four families or species of horses, and as the type differences are so very marked it is important for breeders to know in a scientific way just what they are doing when they produce hybrids of any of these pure types.

And, more than that, if they are to make any success of breeding, then the pure types must be preserved pure, so that the fountain spring of the family can always be returned to for the pure and unmixed blood influence.

In order to understand the results of pure breeding, we must realize that to breed within the family is maintaining the pure type and to breed from one family to another is to produce the hybrid in

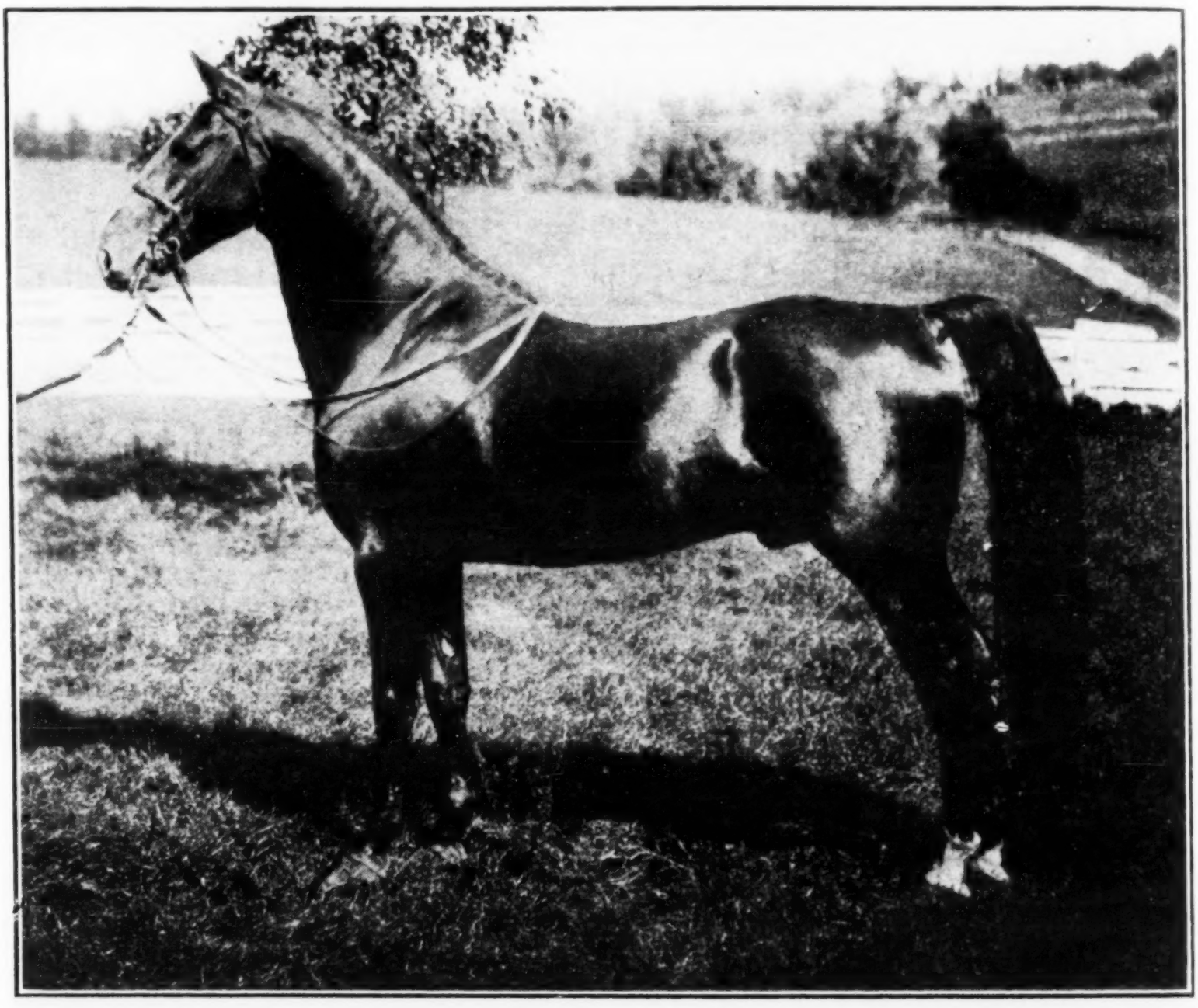


FIG. 14.—MONTGOMERY CHIEF, KENTUCKY SADDLE HORSE.

the same sense that the mule is the hybrid of the ass and the mare. In using the word "hybrid" in this way, I hope I am not misleading. Such a hybrid within the species is fertile, just as the white and black races make a fertile hybrid, but none the less a hybrid. Matings outside the species, like the mare and the ass, the coon and the cat, produce usually a barren hybrid, but all hybrids are not barren. Thus to breed the Connamara pony to the Iceland and the Fjord horse of western Norway is breeding within the family and maintaining the type, and the physical characteristics would thus be accentuated. The offspring would in consequence, if such breeding were continued

for generations, approach more closely to a prepotent type, and by careful selection of best specimens possess ever increasing qualities of excellence.

On the other hand, to breed the Celtic pony to one of the draft types would be breeding out of the family and produce a hybrid. In such a case what number of offspring would resemble one ancestor and what number the other has not been determined by any sufficient

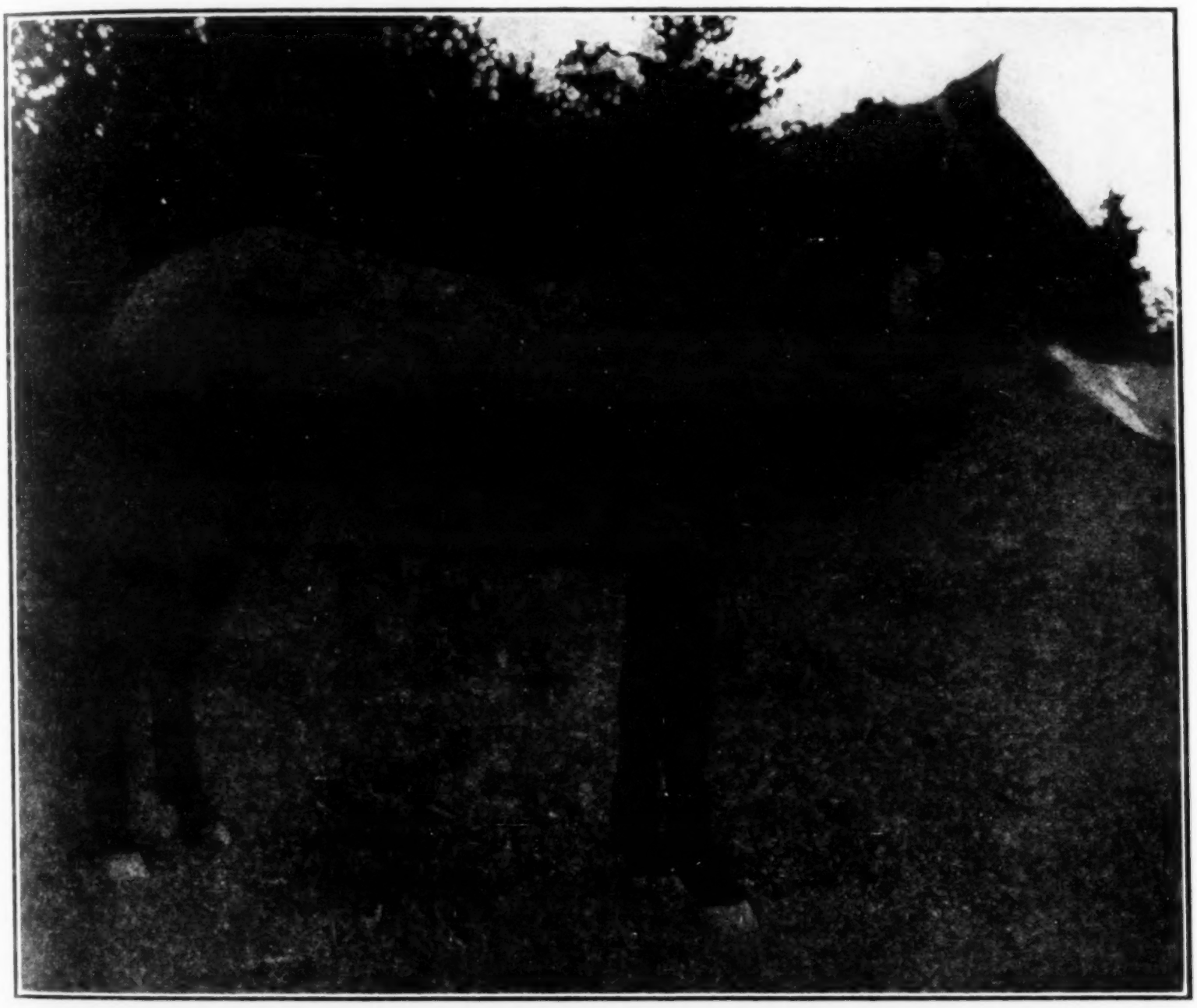


FIG. 15.—BLACK BESS, GENERAL MORGAN'S FAMOUS MARE.

Sire Drennon, son of Dave Crocket—bred at Midway, Ky., dam by Imported Yorkshire, out of Margravine by Margrave. An early type of Kentucky saddle mare. Owned and used for a model by the late Henry K. Brown, sculptor.

investigation, but certain it is that unevenness of produce would prevail or a condition of atavism be established. Every breeder will form his own opinion, drawn by analogy from his past experience, if he will but realize that much of our breeding for the past few centuries has been of a hybridizing character. Thus from the Forest or draft type of mares and the Arab horse, or his Thoroughbred cousin, has been produced the French, German, and English Coach horse, the Hackney, Cleveland Bay and Hunter, Suffolk Punch, etc.

To what extent the Thoroughbred, the American Trotter, Kentucky Saddle, and the Morgan horse may be considered hybrids, I leave for my readers to decide after finishing this paper. We will all agree that they form one family group and are the most closely related to the Arab horse of all breeds in common use here. I do not mean by this any derogatory criticism, for the business of horse breeding has been

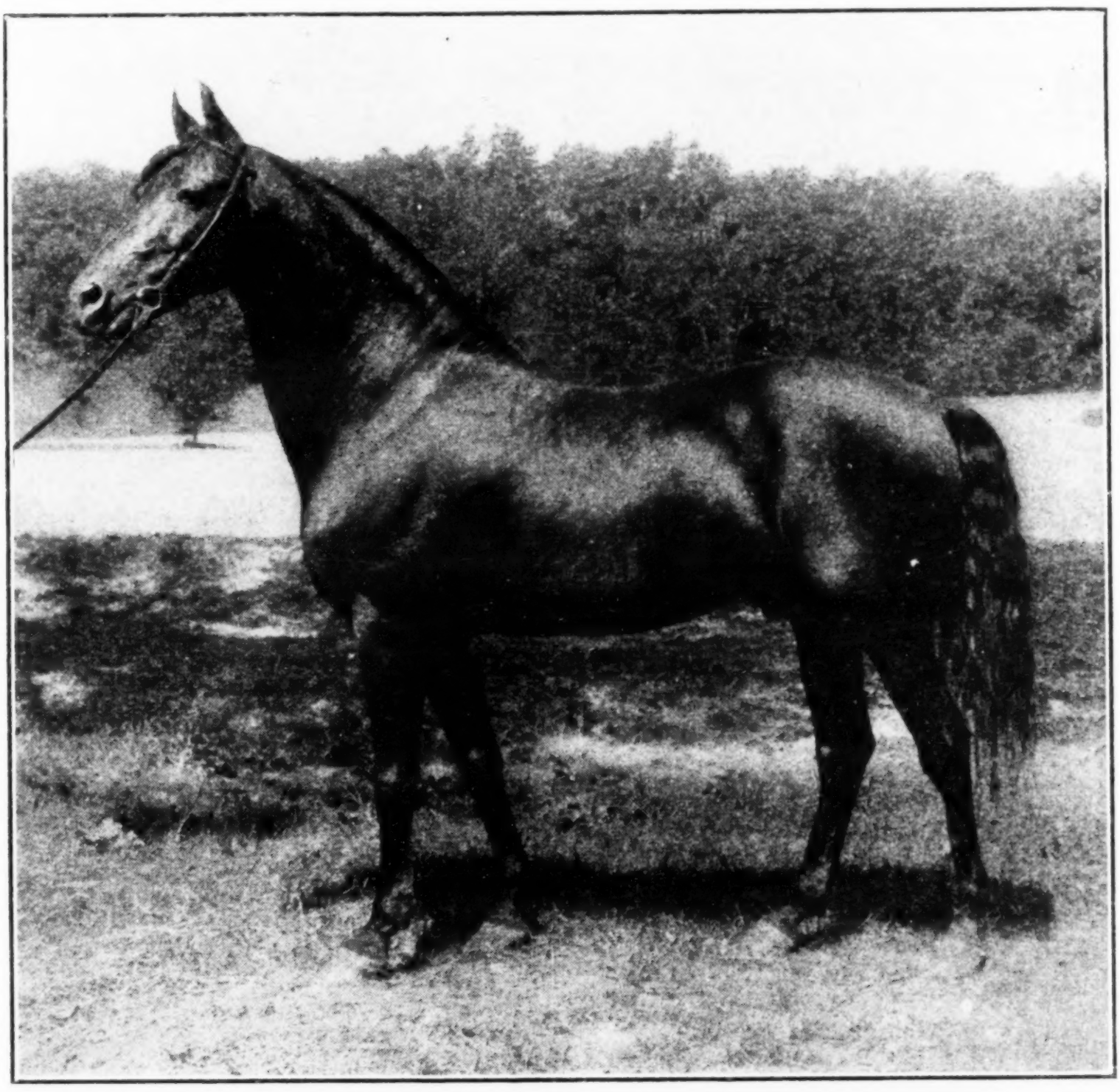


FIG. 16.—GENERAL GATES.
Morgan used by U. S. Department of Agriculture to reëstablish Morgan type.

pursued with all the intelligence available and the results have been good, but we can do much better in the future if the subject can be taken up in a more thorough and scientific way.

I should like to pause here to say that my serious study of the horse began when I was a boy and was stimulated by a visit of Alden Goldsmith to our studio at Newburgh, N. Y. He drove over from Chester with one of his fine trotters and spent the entire day with my uncle

FIG. 17.—MORGAN STALLION DONALD, A. M. R. 5224.

Sired by Bob Morgan A.M.R. 4549, Dam by Ethan Allen, 3rd A. M. R. 3987. The illustration was made from a photograph of the original painting by the artist, George Ford Morris, New York, N. Y.

talking about horses and everything pertaining to breeding and driving them. We had on the studio floor, as means of demonstration, the famous Kentucky mare Black Bess, a very remarkable animal, ridden by Gen. John Morgan in the Confederate army. One statement of Mr. Goldsmith's impressed me very much. It is as follows: "Horsemen and jockeys talk very glibly about 'bottom'; one horse has it and others do not. It seems to me that it is not impossible

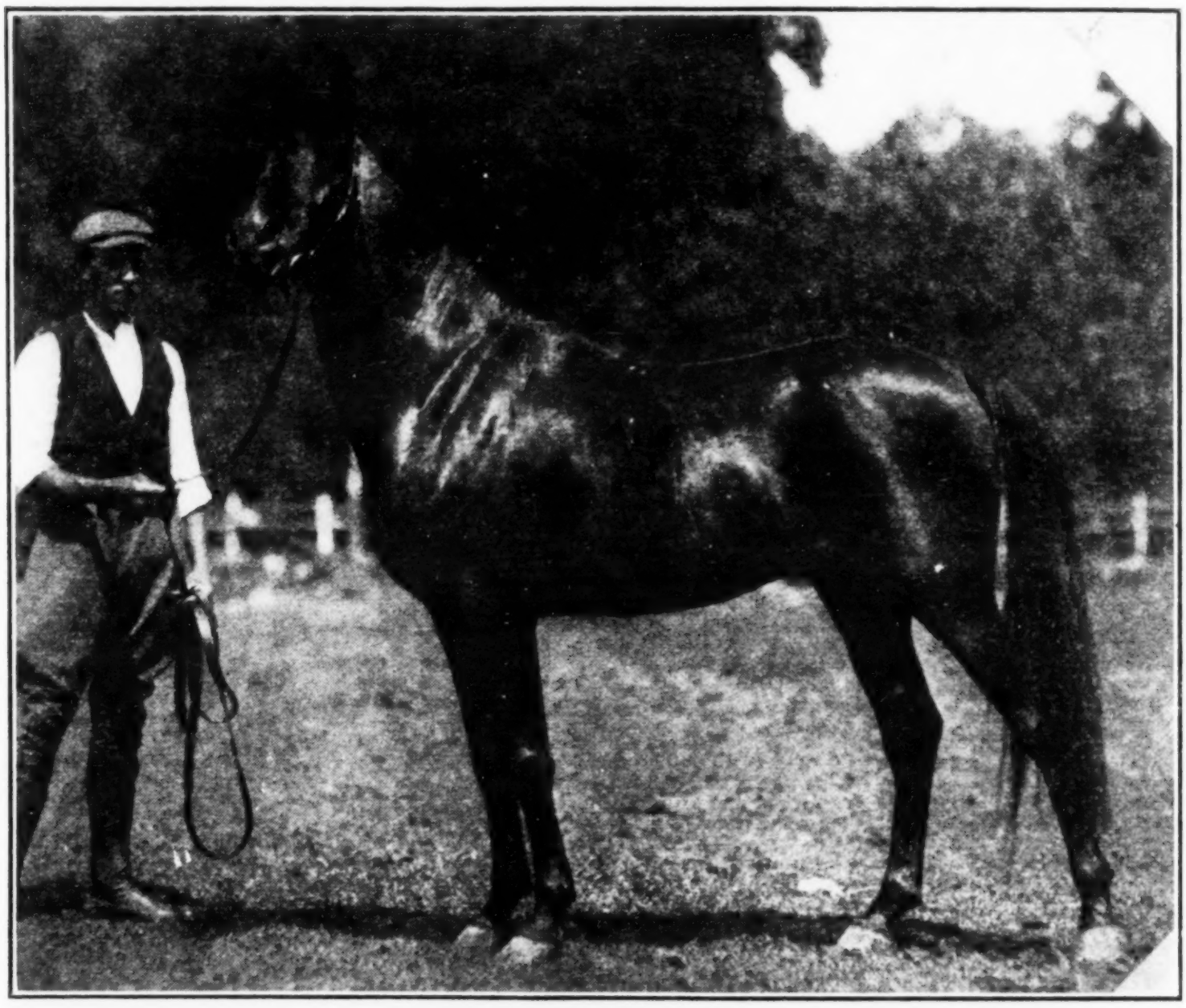


FIG. 18.—HALEB, IMPORTED ARAB FROM THE DESERT.
Shown at Rutland in Morgan Class and given first prize as best Morgan type. Hobb's skeleton is in the National Museum.

that with sufficient study we will find that 'bottom' is merely a question of the length of the forearm and the distance from the thurl-bone to the hock. Extra length in these bones means that the leverage is greater and there is proportionately less bone below the knee and hock to be raised from the ground and carried forward. Thus the work is done with greater ease, and energy is conserved for endurance. In other words, the arms of your compass are longer and they measure more ground every time they are extended." This inspired me to study proportions in horses and to establish a relation of pro-

portion and capacities more carefully than I needed in my profession. I have done some research work but not of sufficient amount to permit me to formulate a standard of measure. All breeders will agree that between proportion and capacity there is an intimate relation, but I do not know any one who has reduced it to mathematical terms.

Here is another line of anatomical study. Suppose, for instance, that we select for anatomical study the Thoroughbred that makes the

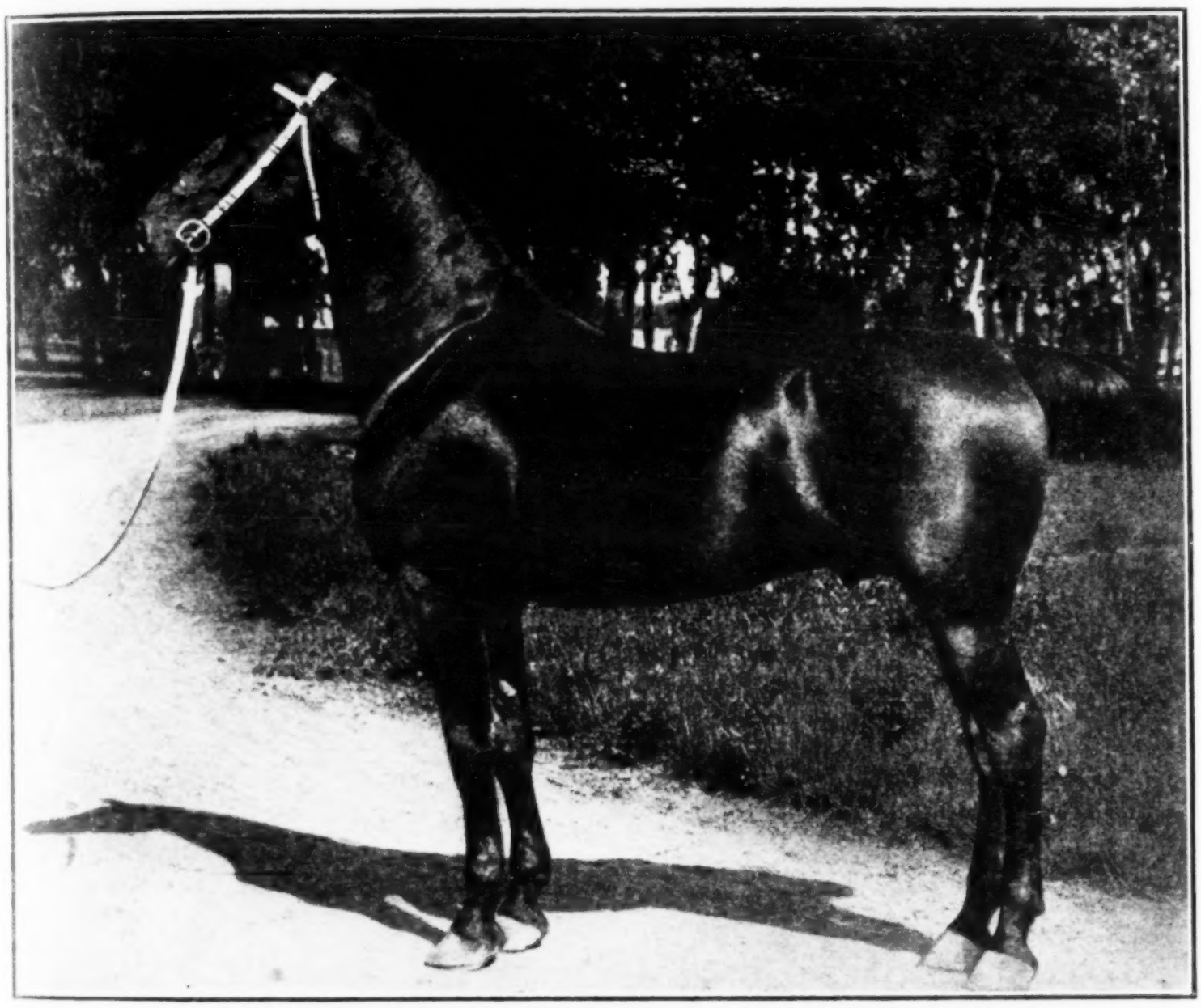


FIG. 19.—CARMON.

Morgan and Thoroughbred used by U. S. Department of Agriculture on the Agricultural College Breeding Farm at Fort Collins, Colo., to establish an American Coach type by breeding to closely allied families. 24, 25, 26 are similar types, bred for conformation.

best record each year and have all his proportions taken while he is alive and in his prime, and then after he is dead have his skeleton prepared and deposited in the Museum for study. Suppose that this is supplemented in England by a study, in the same way, of the Derby winners, and similarly in France for the Grand Prix horses. If these studies were made on a uniform system and the results compared for a series of years, we should know a great deal more about the Thoroughbreds than we do now.

In a similar way we could study the trotting horse and perhaps be able to demonstrate in mathematical terms what constitutes a speedy horse at running and trotting, and then we might determine how best to breed and to select for training. Or suppose we select for study the best producers. Such selection would perhaps serve the breeders a better purpose.

The Museum of Natural History of New York is the best equipped

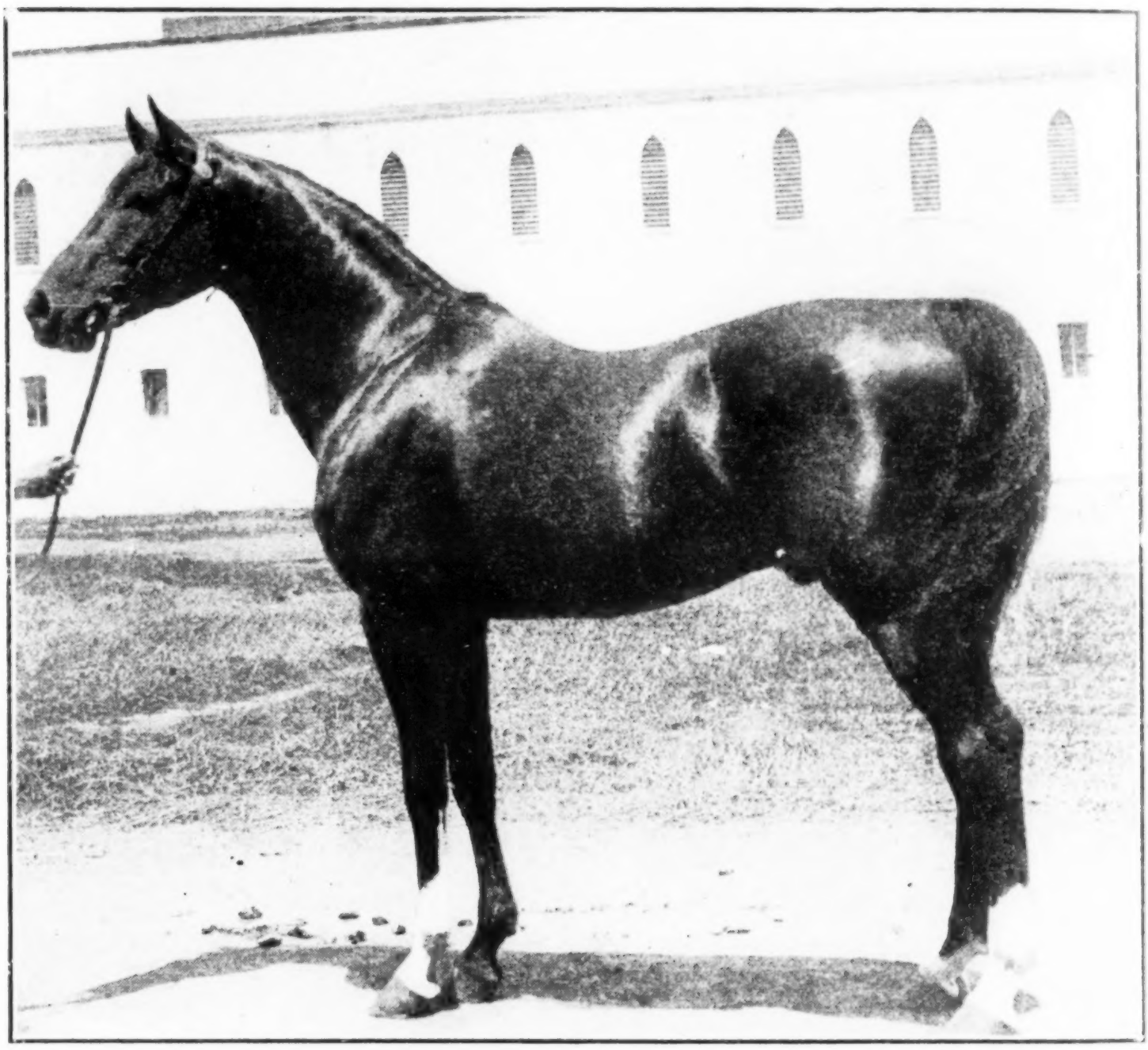


FIG. 20.—KHALED, SON OF NIMR.

to do this research work, as it has a department exclusively devoted to the study of horses. It will do all the laboratory work and issue reports free, provided the prepared specimens are sent it. To have the specimens prepared costs about forty dollars apiece and the breeders of horses should make their own selection and pay this first cost, as it is a special study in the interests of breeders.

Inasmuch as the blood of the Russian Prejevalsky does not seem likely to produce results of practical or artistic value, we may leave him in the Zoo as a curiosity. Thus we have the Celtic ponies, the

European Draft or Forest horses, and the Arabs as the three great families of useful horses. I look for very beneficial results from crossing the Celtic horses, the higher types of which are very serviceable and sturdy little animals, with the larger types of American horses, such as the Morgan, the Trotter, and the Thoroughbred.

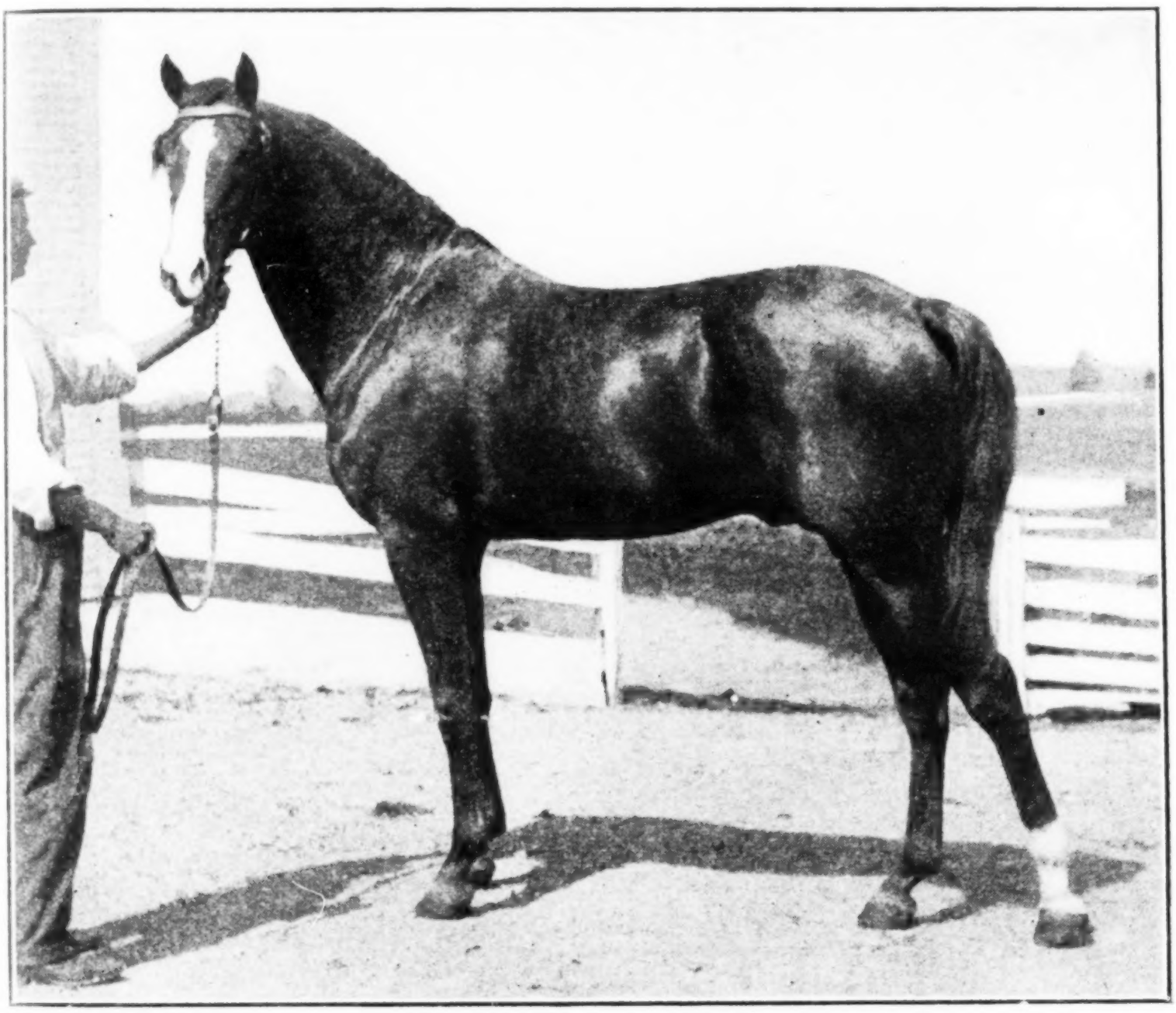


FIG. 21.—CLAY CHILDERS.

Americo-Arab, a grandson of Nimr and a grandson of Linden Tree, one of the Arabs presented to General Grant by the Sultan of Turkey. The rest of the breeding is inbred Henry Clay, National Stud Book, Class "E," No. 4.

I should like to suggest here that the little Canadian pony, such as I remember in my boyhood, may have been a kindred of the Celtic pony.

To sum up our argument, then, the breeder should always keep the three families of horses and their constituent subgroups clearly in his mind as three distinct types or species, and in his breeding follow some definite law of continuity, such as to breed twice away from the pure type and once back to it. By laying out his own plan of procedure and recording his results he will have great joy

and success in his breedings and leave for others the benefit of hi experience.

If there is any advantage in a horse having five lumbar vertebra instead of six, the American horse breeders want to know it. A series of reasonable tests, such as mounting one-half a regiment of cavalry with purebred Arab horses, would help determine this question.

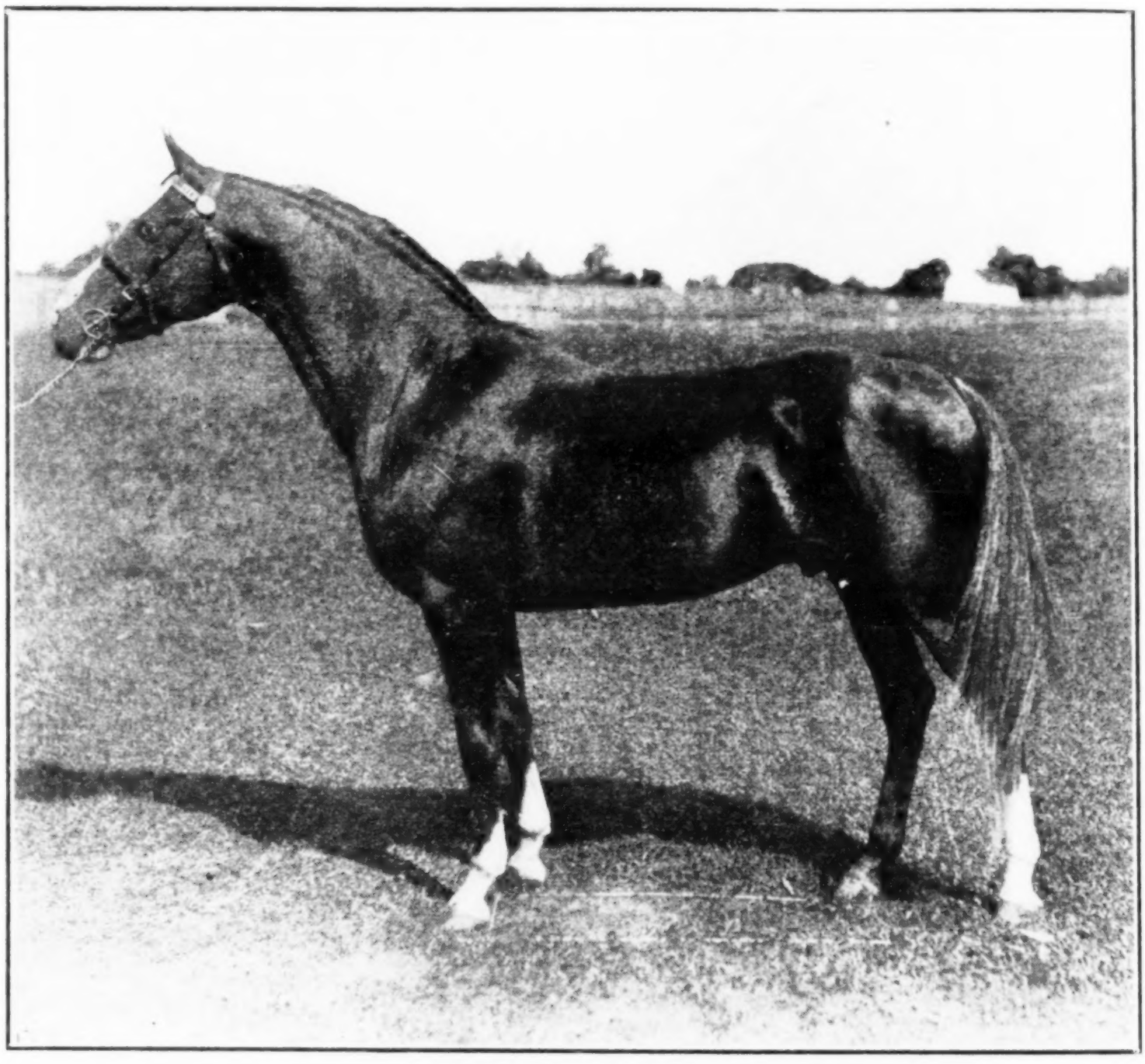


FIG. 22.—THE GREAT PRIZE WINNING ARAB STALLION ABDUL HAMID II.

Sired by Leopard, one of the Arab horses presented to General Grant by the Sultan of Turkey Abdul Hamid II. Dam an inbred Henry Clay mare. The result of breeding to a closely related family. Observe the Hogarth's line of beauty in his neck. First prize New York National Horse Show, 1894; First prize Baltimore Horse Show, 1894; Championship International Horse Show, Buffalo, N. Y.

Furthermore, a study into the tendency of nature to develop in the hybrid the qualities of its parents would be of infinite value to horse breeding. Here is a kind of research that is almost untouched and which appears to give promise of the greatest practical result, and I am of the opinion that such thoroughgoing scientific research will give a character to horse breeding that it does not now possess.

To keep within the family group or true-breed is not a new idea, for breeders of all the types have kept strictly to it in the subdivided lines, but too much in-breeding almost invariably produces degeneration. This is immediately corrected and revitalized by a return to one of the primitive types that have been kept pure.

We are yearly paying thousands of dollars of tribute money to Europeans for breeding stock and are content slavishly to follow their lead to merely perpetuate and continue the studbooks they have established. The exceptions to this statement are the Morgan horse, Kentucky Saddle, and the American Trotter; these are types of our

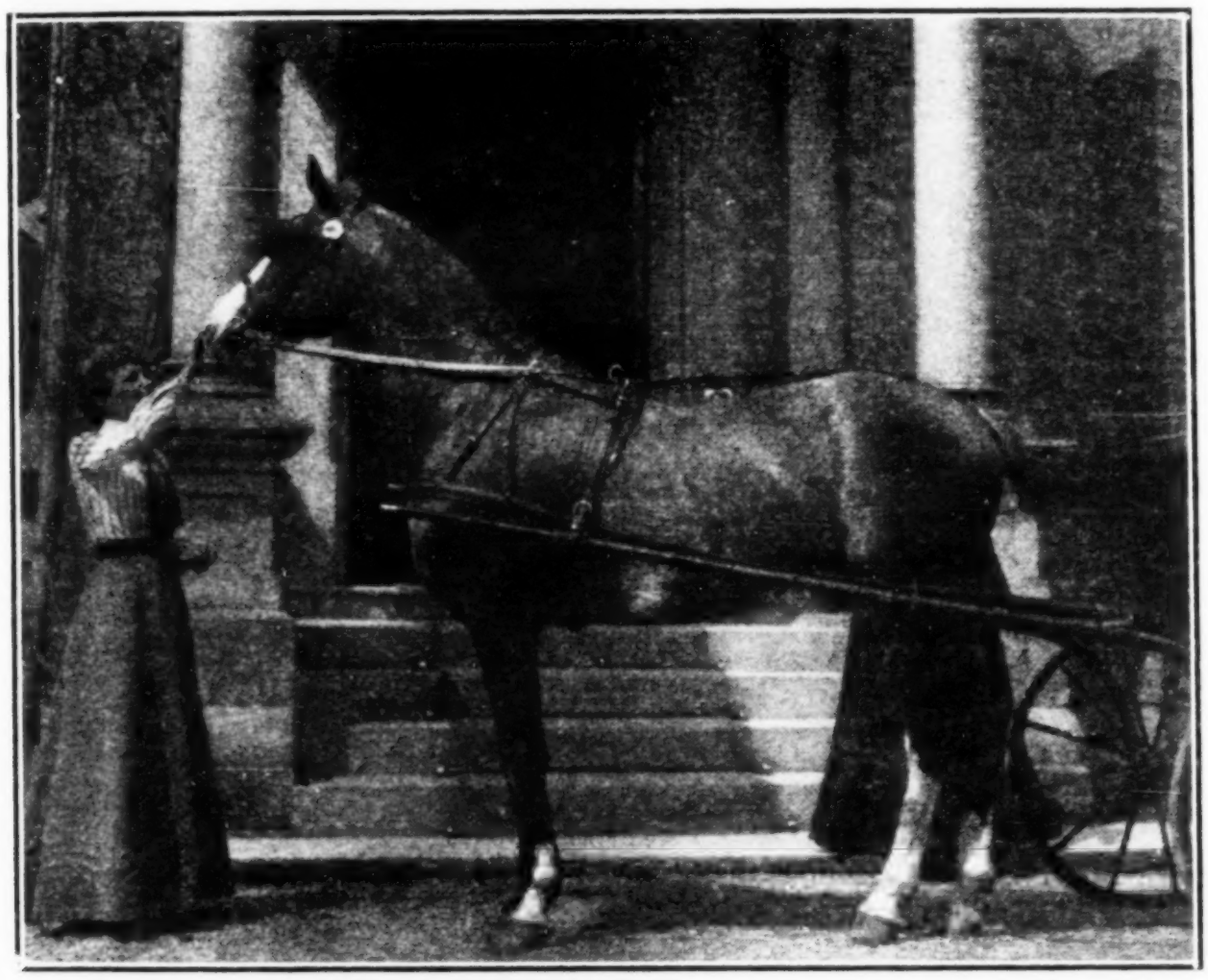


FIG. 23.—FEZ, A SON OF ABDUL HAMID II.

own of which we are proud, and the success here attained should give us courage to move forward and attain greater things.

Furthermore, we have the best Thoroughbreds in the world and of such quality that by carefully selecting them for breeding purposes and by crossing them with the above-mentioned American types we may produce higher types of the general utility horse than we have seen heretofore.

We have a goodly quantity of the two living primitive types, the Arab and the Celtic horses, and every subdivision of the draft type. We have therefore all the material that any people have for maintaining and strengthening the established types and for creating new ones, if we wish to do so.

Thus with scientific research and the application of knowledge gained to horse breeding we will become not only independent in our breeding, but the leaders of the world in the industry. Besides the live stock, we have the greatest variety of soil and climate, with well distributed and extensive grazing land.

The establishment of the Arabian Horse Club and their Registry of Arab horses was an important event in this country. It is the only studbook in the world, so far as I know, that continues the breed-

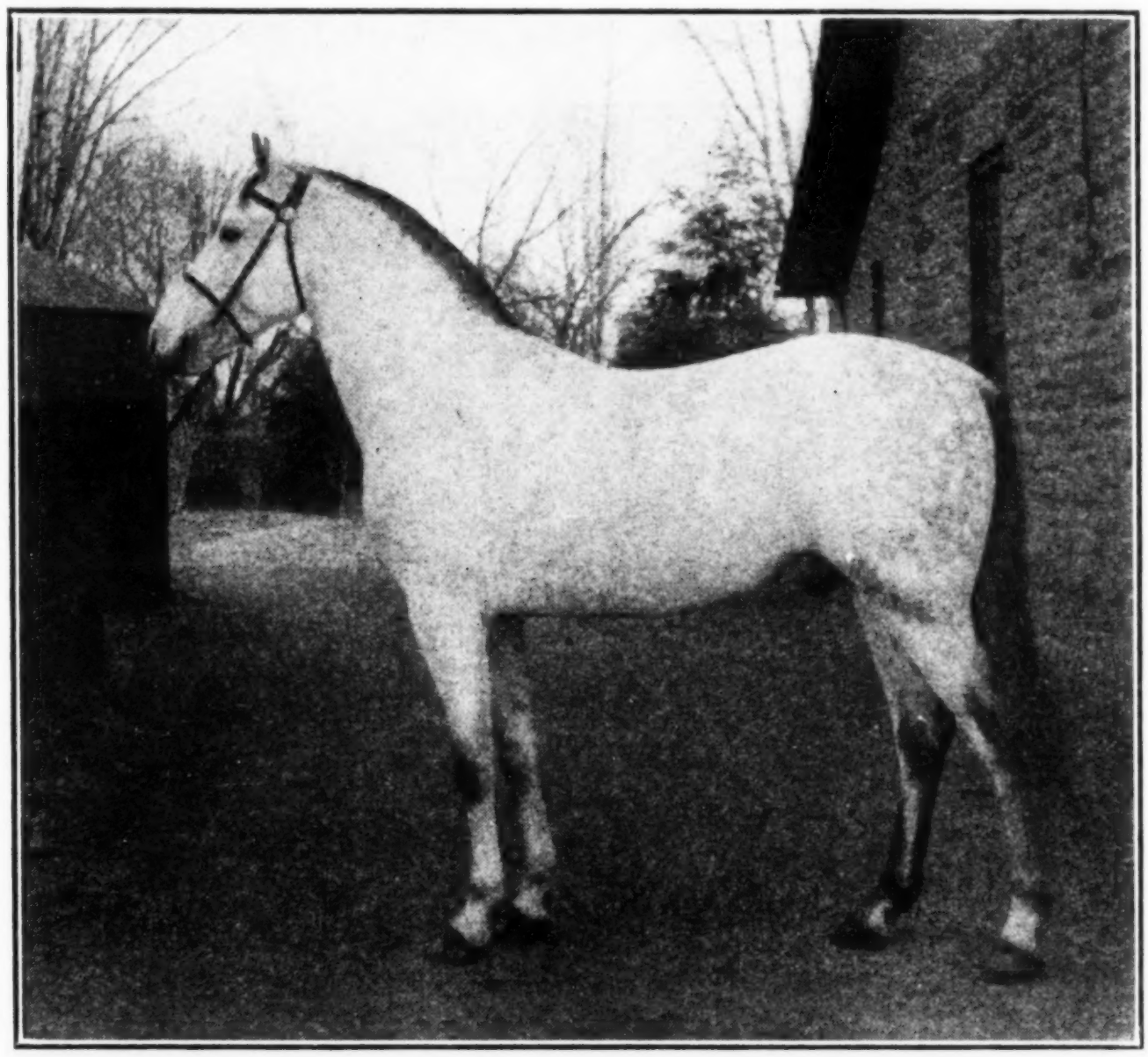


FIG. 24.—KASIM, SON OF ABDUL HAMID II, DAM AN INBRED HENRY CLAY, STRONG IN MESSINGER BLOOD.

ing of the Arab horse in its absolutely pure type just as the Arabs have bred it ever since the earliest times in history.

This should be followed by the establishment of registry for the Norway horse, the best representative we have of the Celtic type.

The National Studbook was established for the purpose of discovering the result of breeding the Arab horse to his closely related families in this country, the Thoroughbreds, Trotters, Kentucky Saddle, and Morgan horses. At the same time it gives free scope to the breeder who wishes to follow either narrow or broad lines in breeding and holds him strictly responsible for what he does. If he wishes to con-

centrate on existing types he can do so, and if he wishes to go afield and establish new ones he can do that and have the records of his breeding kept, so that if he succeeds the world will know how he attained his results, and if he fails it will also know how to avoid failure.

I believe no studbook has ever attempted to do this before, for the reason that heretofore race types have not been understood as they are now.

The effect of following the rules of the established studbooks has been to restrict breeding to the animals already registered and to

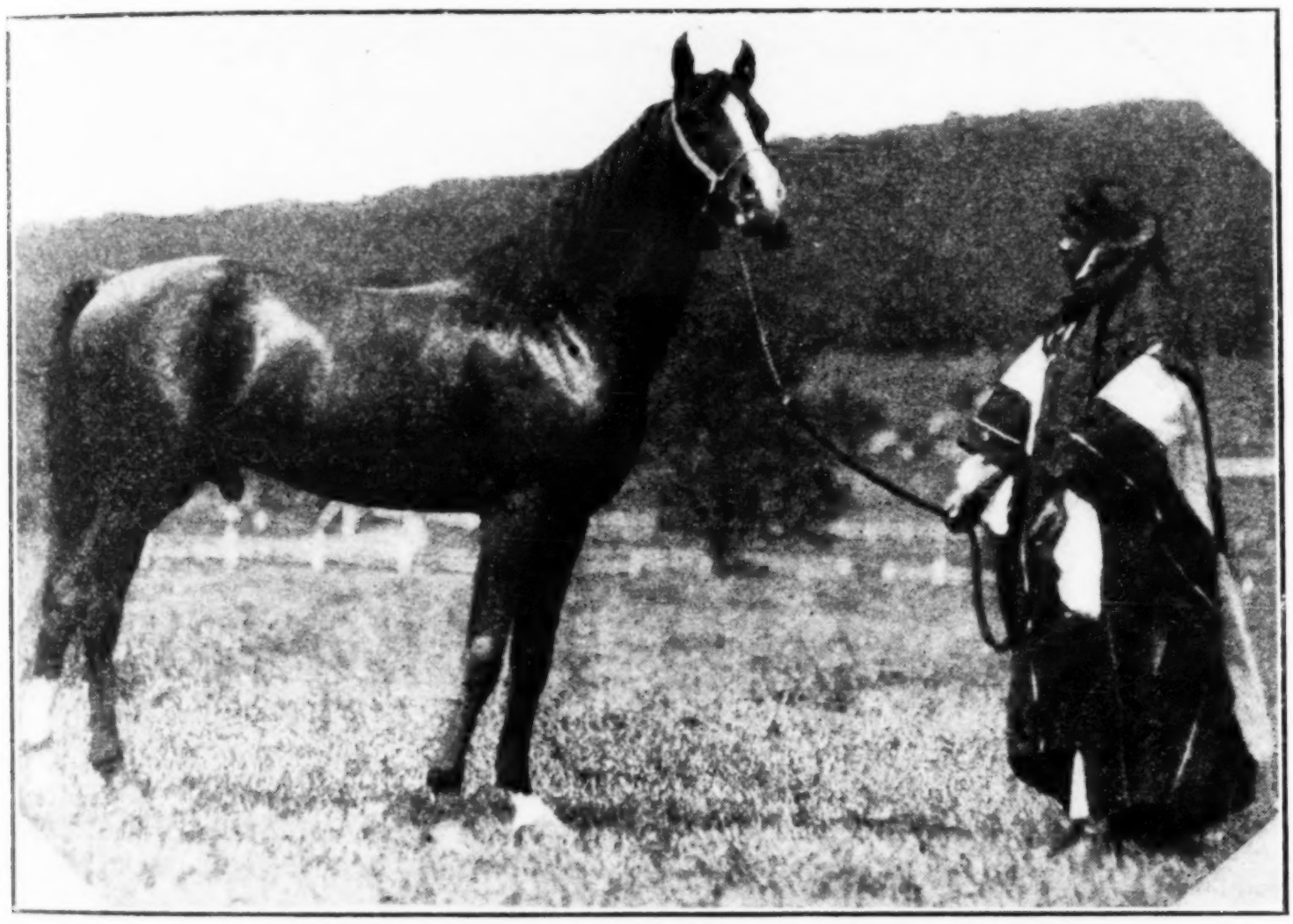


FIG. 25.—HOURAN, IMPORTED PURE ARAB BRED IN THE DESERT.

discourage the combining of closely related families which the laws of science required in order to attain the best results. What a horse is and what he can do is, however, the final test.

By making no restrictions other than keeping the classifications distinct, the National Studbook's rules leave it to the breeder to make his own plan and to prove his plan of breeding to be the best. The record discloses the breeding, and the photograph shows the result.

These studbooks require a photograph of the horse to be deposited, a form of record that is not now expensive and is quite worth while as a record of what is being produced.

For registration of existing types in this studbook it requires something more than speed records; there must be evidence of individual Arab characteristics to be worthy of breeding to the pure Arab.

By careful selection we will build up a selected Americo-Arab type. The United States Department of Agriculture has taken the initiative in this matter in selecting for restoring the Morgan type and in creating an American Coach horse.

By a proper coöperation and system of circuit breeding of selected units from our best native stock, we can establish a higher respect for the American-bred horse and become a nation of exporters of high-class horses instead of a nation of importers. We will have the best that soil, climate, science, and care can produce.

BREEDING OSTRICHES FOR PLUMES

CHARLES F. HOLDEN
South Pasadeña, Cal.

Twenty odd years ago Mr. Edwin Cawston conceived the idea of raising ostriches in southern California on a commercial scale. He went to Africa, collected some fifty good birds and arranged to have them shipped to this country. Many difficulties had to be overcome, not the least of which was the opposition manifested on the part of the South African Government. However, a few of the birds were finally landed safely in southern California.

Since that time immense improvements have been made in ostrich feather growing by applying American methods. The ostrich feathers of Africa are produced at times under very poor or adverse conditions, whereas the American ostrich feathers are the product of careful breeding, feeding, and care in the congenial climate near Los Angeles. The result is that the feathers are much finer, glossier, and stronger.

This ostrich farm is one of the most delightful spots in southern California. Originally it was one of those oak-clad arroyo banks found at intervals. All these splendid trees were preserved and made part of the general effect, many rare plants and shrubs being introduced. With judicious terracing, cobblestone ditches, and paths, fine landscape effects have been secured. In few places can one see such fine examples of Asparagus Plumosus, many of the fronds extending up onto the roofs of the buildings and high up into the oak trees. There are also splendid examples of ivy-draped oak trees.

The ordinary ostrich egg weighs about three and one-quarter pounds. The eggs are laid one every other day until twelve or thirteen have accumulated. Sometimes the mother bird refuses to sit, in which case the eggs are put into an incubator for the reason that the male bird, which usually covers them during the night, will not do so unless the mother covers them during the day.

In about forty days the eggs begin to hatch, and the chicks come out full fledged and quite strong, standing about twelve inches high. They are covered with short stubby feathers reminding one of a bunch of dark colored excelsior. For the first two or three days they eat nothing but bits of gravel and shell. Then they begin on the tender shoots of alfalfa and other green food.

The ostrich chicks grow very rapidly, increasing in size about a foot a month. During this period they require a great deal of attention

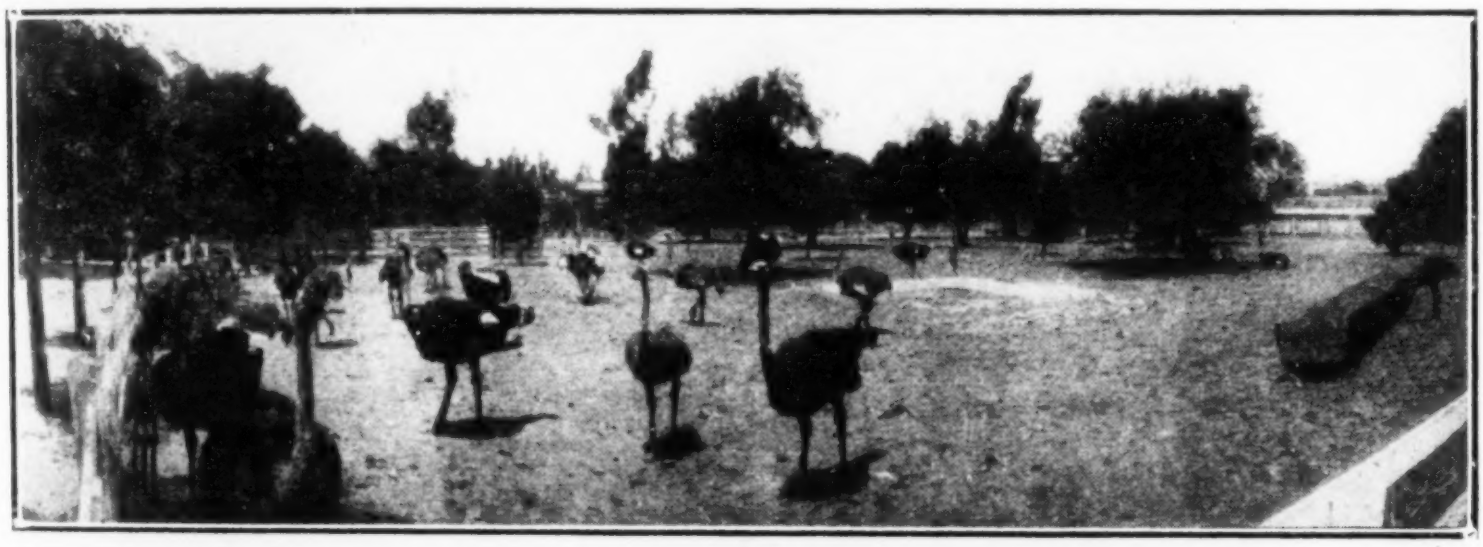


FIG. 1.—PADDOCK ON AN OSTRICH-BREEDING FARM IN CALIFORNIA.

as they receive no care whatever from the mother birds. During the incubation, however, the mothers are very faithful, covering the eggs during the hardest storms, even if the nest, which is merely a hole scooped in the ground, becomes filled with water. Young ostriches do not show any distinction of sex until they are fourteen months old, when the male takes on the black feathers.

There are two recognized varieties of African ostrich; the Nubian, which is the larger of the two, sometimes reaches a height of nine and one-half feet. The tallest ostrich in the Cawston flock stands eight feet high. When tempted with an orange or other dainty it can reach to a height of fully ten feet. The average height of these birds is seven feet. The eggs of the Nubian bird are larger and quite smooth and weigh between three and four pounds each. The period of incubation is forty days. The feathers of the Nubian are more curly but narrower than those of the South African ostrich. Crossed with

the South African they produce a finer grade of feathers than do either of the parent stocks.

The birds are plucked about every eight or nine months. They are not really "plucked" at all, but the wing plumes and the tail feathers are carefully clipped, one at a time, the stump of the quill being allowed to remain until it drops out of its own accord.

Feathers are graded to an exact scale. First they are sorted as to color. Then each given quality is assorted as to length, varying from the short ones up to plumes twenty-four inches long. Then each length is sorted as to width, there being six widths. This means that there are more than five hundred distinct grades of feathers. It must

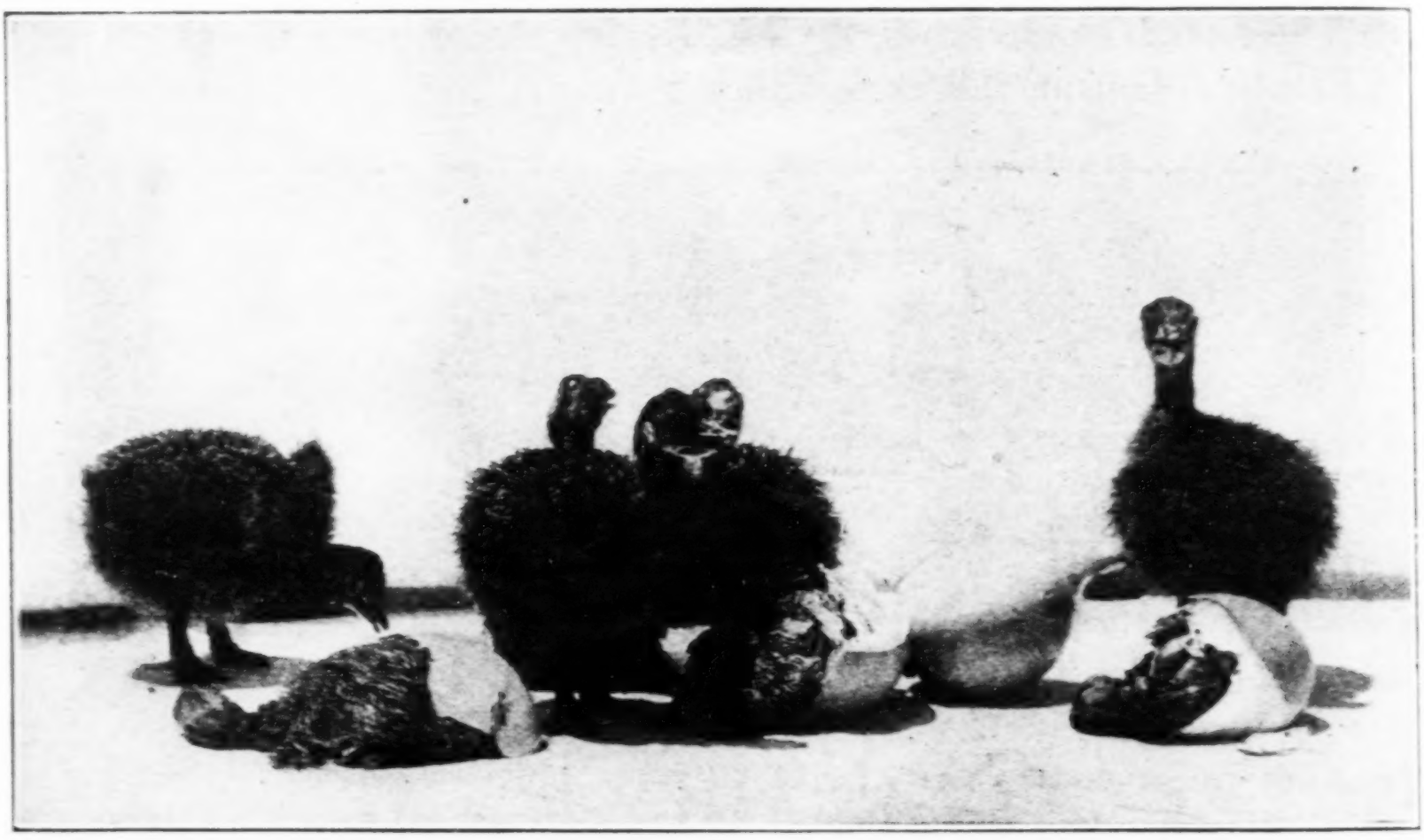


FIG. 2.—CALIFORNIA OSTRICHES.

not be understood that this refers to colors at all. These five hundred different grades are each of them dyed into almost innumerable colors and shades, and one can therefore see that the total stock comprises thousands of varieties. The sizes of the fancy first grade feathers are about twenty-one inches in length and about fifteen inches in width. This size is worth on the market about $400 per pound; it takes eighty feathers of this size to weigh one pound, approximately. On the tip of each wing of the male bird there is one single feather called the bycock. It is a natural mottle of white and brown, and very beautiful. The black and the white feathers of the male birds are of equal commercial value. The feathers of the female bird have a value of

about 20 per cent less than those of the male. The average value of a plucking per annum is about $25; exceptionally good birds are worth as high as $45. Each wing has twenty-six plumes. There are about sixty tail-feathers. The feathers on the body of the bird have very small value and are used in making boas and other cheaper grade feather articles.

When feathers come to be manufactured after being dyed, the first process is another careful sorting for quality. It is as if a barrel of apples were graded, first for size and then were examined one by one to see that each conformed in every minute particular to the standard. Thus are brought together in each plume or boa or other article feathers not only of the same size and general quality but of such a texture that each will curl in just the same way.

Although the ostriches require a great deal of attention when small, once they are grown they are very hardy. So far the only disease known among the ostriches is what is called the Douglas worm, a minute parasite which clings to the walls of the stomach. This is not of a serious nature.

The neck of an ostrich is a wonderful part of its anatomy. The average length of the neck is a little less than three feet, but in the flock at the Cawston home farm, there is one big Nubian female with a neck measuring three and one-half feet. An adult ostrich when in full swing covers about twenty-two feet at a stride and can easily outdistance an ordinary horse. Their gait, both in running and walking, has a peculiar swinging roll which at first seems awkward, but there is a rhythm about it that is really very graceful.

The bill of an ostrich opens fully four inches, and an adult one makes no trouble over swallowing an orange whole—a big navel orange, with a diameter of three and one-half inches. Moreover, some ostriches will catch these oranges as fast as they are tossed, swallowing one after another until ten or twelve huge globes can be counted rolling down the long neck at the same time. The California ostriches are almost equally fond of sugar beets and quickly snap up rectangular chunks measuring from three to four inches, disposing of them much the same as they do of the oranges. The old saw about "a stomach like an ostrich's" is not altogether beside the mark, for the ostrich will eat literally anything, including nails and glass. They demand large quantities of gravel or other gritty substance. The omnivorous appetite of the ostrich often gives rise to amusing incidents at the Cawston farm. Perhaps the queerest stunt of all was when one old patriarch shot his head over the railing

and seized a long green veil fluttering from a lady's hat. Nor did he stop until he had drawn the veil off and swallowed it entire! An ostrich eats nearly one-fourth as much as a cow. They are extremely fond of green alfalfa and eat several pounds a day. They are also given large quantities of such vegetables as carrots, beets, turnips, etc. Their diet must be carefully arranged if they are to produce the silkiest and glossiest feathers. Rational methods of feeding and handling have increased the feather production of the birds very considerably.

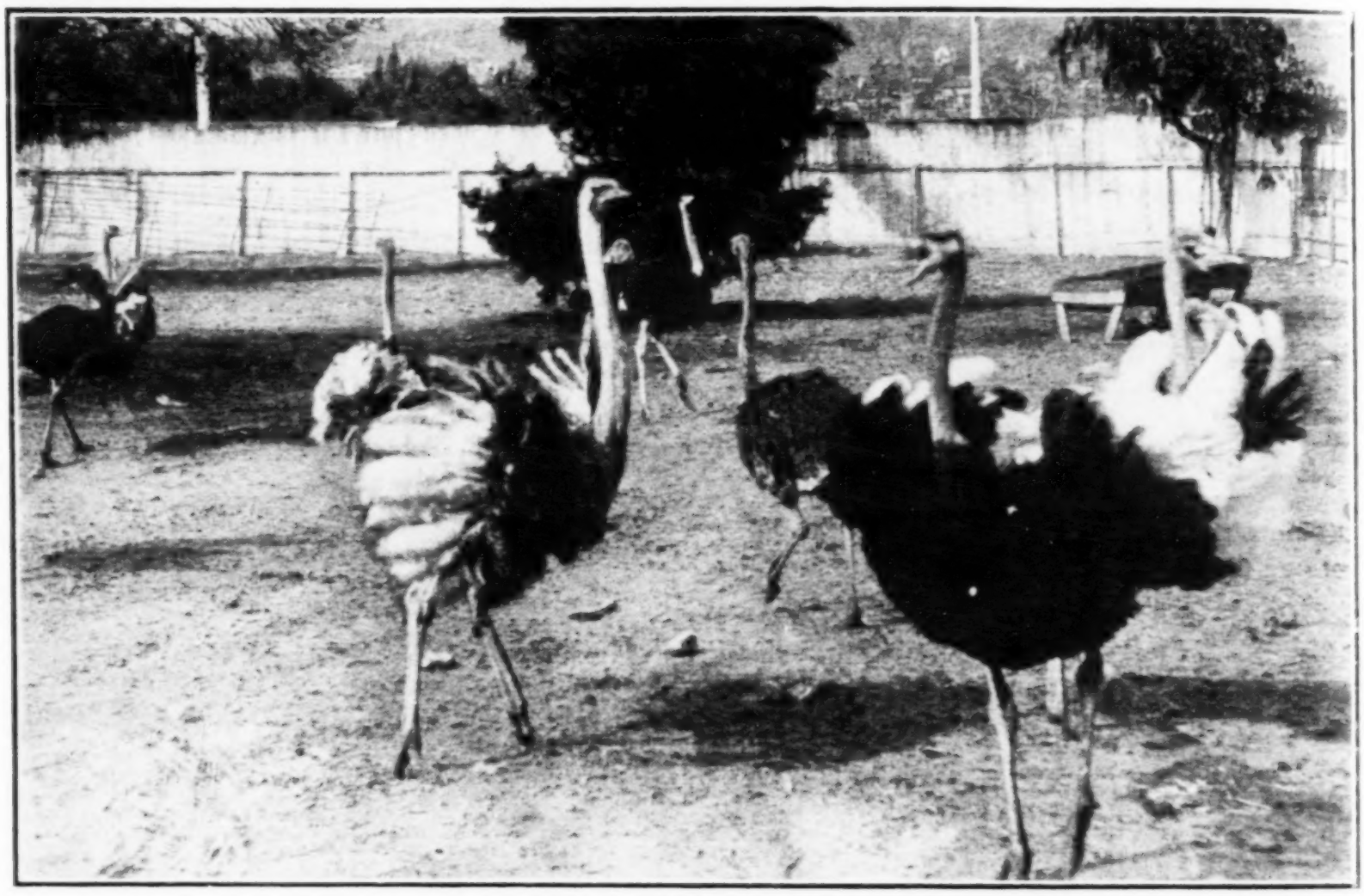


FIG. 3—MALE AND FEMALE OSTRICH.

Of all animals, the ostrich has the smallest head in proportion to its body weight. The eye is about in proportion to the size of the bird and therefore appears out of proportion to the rest of the head. The ostrich's eye is about the size of a good-sized marble. However, he can see the most minute object. They are particularly attracted by anything that sparkles or glitters, and it is dangerous to be near them with any article of adornment. The eyelid of the ostrich does not move over the eye, but instead there is a separate film which flashes across it from time to time, reminding one of the shutter of a camera.

Attendants declare that these birds have no brains. They say that the man who has fed them and cared for them for years takes just as much risk in going into the pens as the utmost stranger. They

seem to manifest no feelings of affection or of friendship, such as most other birds or animals do. They are extremely treacherous—or a better word is "finicky"; a trivial circumstance will enrage them. They start a fight against other birds or against the keepers without any discernible provocation.

When an ostrich issues a formal challenge to fight, he sits down, spreads out his wings, draws his head back against his body, and then repeatedly flaps his wings while waving his head from side to side and bringing it against his body with a resounding thump. This is evidently more of an attempt to frighten off the enemy than a preliminary to fighting, for if one of them really wants to do damage he does not wait for any such preliminaries but issues a screaming hiss, throws up his wings, and pounces upon his opponent. The fighting is all done with the feet, for the bill of an ostrich is comparatively soft. The foot of the ostrich consists of one long toe, sticking out directly in front, which ends in a heavy thick claw, and a slightly shorter toe on the outside, standing at an angle. He fights by kicking—it would be more accurately described by the word "striking"—for he raises his foot as high as possible and then brings it down with a blow that would fell a cow. When ostriches are kept in flocks many individuals may be noticed whose breasts are torn and scarred from the savage down-cut of that cruel spur. Most commonly their fights are over family affairs. Ostriches mate for life and once mated the male will tolerate no interference from the unmated birds. This recalls that about four years ago one of the finest birds at the home farm killed his mate in the night by kicking her to death, and the attendants aver that it was because he was jealous of an unmated bird in the adjoining enclosure. He was afterwards turned back with the unmated birds and selected a new mate with which he has lived peacefully for four years.

The best producers at the farm are George and Martha Washington. These birds are twenty-four years old. They seem to have profited by their experience, for they hatch more chicks at a setting and do it with less fuss than any other pair. The attendants claim that they leave their nests longer and spend much less time and trouble than other pairs; still at each setting last year they brought off eleven fine chicks, whereas it is not unusual for a pair to secure only three or four or five chicks. If this pair have actually been as successful in past years as last, they would now have to their credit four hundred and forty ostriches. The life of an ostrich is between 25 and 35 years.

SEPARATING HEREDITY FROM ENVIRONMENT[1]

F. Adams Woods
Brookline, Mass.

The question of the relative influence of heredity and environment has been a subject for debate since ancient times, but the results of such debates have not been clarifying. Indeed many have doubted that it is possible to separate the two interwoven forces; but this confusion and lack of progressive agreement in our ideas on the question I believe to be due to the failure to disjoint from the general problem each separate specific question and then to treat each separate inquiry by the methods of an approximately exact measurement. If this is done a certain amount of agreement can be at once established and the beginning made for a true science of the subject. Because a resultant is caused by two combined forces it is not necessarily impossible to resolve their relative strength. Viewed from one point of view, the problem certainly does seem hopeless; that is, it does not seem possible to gain any light as long as the discussion hangs upon the development of a single individual organism. Here it may be said that both conditions are of equal importance, or one may well contend that each aspect of the question is of supreme or absolute importance. In fact one may take any position one chooses and debate forever without arriving anywhere. For each separate creature, regarded apart from any others, the germ-plasm potentialities are one necessity and the air, water, food, and other environmental factors are another, and no one can separate the two. But as soon as two or more individuals are made the subject of the discussion we can begin to see possibilities of estimating the relative value of heredity and environment, not on the production of each individual separately but on the *differences* that exist between the two.

To make any distinction of this sort it is necessary to define heredity as the sum total of what is present in the single fertilized germ cell. It is important for the discussion to accept some such definition as this, and not the older idea that heredity means a resemblance between offspring and parent. As an instance to clear up this definition, and at the same time prove that it is at times possible to separate heredity and environment, we have but to think of the example of the gray and white mice or the black and white rabbits. All our breeding experiments show that in certain cases albino animals may be

[1] Read at meeting of research committees of the Eugenics Section at Munson State Hospital, Palmer, Mass., May 2, 1911.

surely expected from the mating of two colored parents. Here there is no resemblance whatever to either parent as far as color is concerned yet everyone will admit that these differences in color are due to differences in germ-cells and not to differences in environment. In the same way the anatomical sexual differences among the vertebrates are now for a great variety of independent and confirmatory reasons held to be due to germ-cell or predetermined differentiations and not caused by alterations in the food supply, heat, moisture, or other external agencies. In contrast to these cases, let us consider one or two examples of observable differences which are almost entirely the result of external surroundings. It would be readily admitted that any normal child of Caucasian parents might be made to speak English, French, or German, according as he were brought up among one or all of these three peoples. Whatever may be the inherent differences among individuals in their ability to learn languages, by far the greater part of the world's linguistic differences are obviously due to nurture and not to natural differences already present in the germ-cells. I have recently noticed a tabulation of the divorce statistics of the civilized nations of the world. Japan shows the highest ratio, United States next, and England and Ireland among the lowest. It is evident that the distribution of these differences does not accord with racial descent. If it did we should have no way of separating the inherited psychological factors from the social. The result might be due to either cause operating singly or to any hypothetical proportion of the two causes acting together. As it is, we may be sure that a large proportion of these differences are due to something other than physiological heredity, though our present knowledge of racial genealogy does not enable us to say just how much. Another instance of a resulting difference due to external circumstances would be shown if a farmer cultivate two plots of ground side by side of equal richness, and, after sowing a large amount of seed of equal average quality, he then applied a chemical fertilizer to one plot and not to the other. Since the average heredity factor would remain the same he could by shifting one external condition and keeping the others approximately the same, measure also any one of the other external forces, sunshine, soil, or water. These easy instances show that it is possible to get a certain amount of agreement as to relative values—as to what can be done and what can not be done through outwardly imposed conditions. It is only a question of how far we can go. The researches of the future alone can decide.

Already it appears that certain generalizations hold as to the rela-

tive influence of environment, or, better, "modification," which i the more technical word. In Popular Science Monthly for April, 1910, I have brought together and analyzed the results of most of the modification experiments so far reported. These may be summarized in part and briefly as follows: Each organism, whether high or low in the scale of evolution, has from the time of conception and beginning of cell division, onward through embryonic and post embryonic life, an *expected* environment. In other words, it *expects* to develop and live under conditions which are essentially similar to those which surrounded its immediate ancestors at each stage of *their* career. If the expected environment is altered, then the modification which will accrue will in general diminish (1) in proportion as the change from the expected diminishes, (2) as the phylogenetic rank increases, (3) as the evolutionary rank of the tissue increases, (4) as the age of the tissue increases, (5) as the organism's power of choice increases. All this leads us to expect but little modification of the important mental and moral differences found among adult mankind. Researches on twins and my own statistical investigation concerning royalty as well as the more recent reports from the Eugenics Laboratory in London show that the rougher human differences are due almost entirely to heredity. Just where and when environment can be counted on to act remains to be determined. The point I wish to particularly emphasize is that each problem must be treated separately and in the light of specially contrived experiment or by specially devised analysis of statistics already in existence. In this way a science of the subject will slowly but surely grow.

SUGGESTIVE LABORATORY EXERCISES FOR A COURSE IN PLANT BREEDING[1]

ARTHUR W. GILBERT,
Laboratory of Experimental Plant-Breeding, Cornell University, Ithaca, N. Y.

In a recent investigation made by the writer into the status of plant-breeding instruction in this country, it was found that one of the most irregular and un-uniform features of our present instruction is the laboratory work. This problem of methods and materials for laboratory instruction should demand our serious consideration. The quality of instruction is often measured by the amount and nature

[1] See article, by same author, on Lectures for a Plant-Breeding Course, in the Annual Report of the American Breeders Association, Vol. VI.

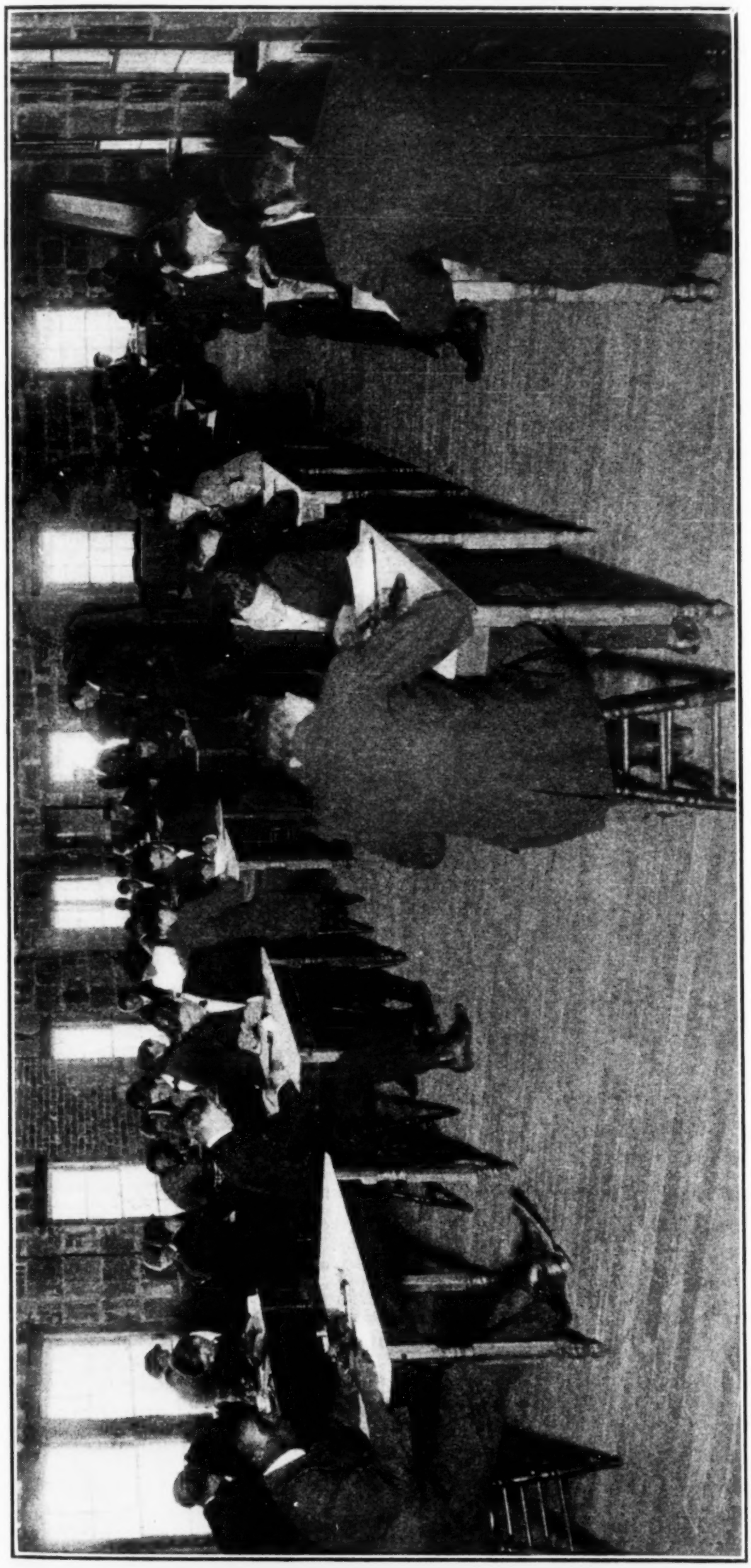


FIG. 1.—A CLASS OF STUDENTS AT CORNELL UNIVERSITY STUDYING THE MORPHOLOGY OF FLOWERS IN THE PLANT BREEDING LABORATORY.

of the laboratory work. There is no field of agricultural instruction which offers a greater and more valuable assortment of laboratory material than plant breeding.

The exercises here presented are merely suggestive. The length of time required for students to carry them out will vary with the exercise. The first one, for example, will require several weeks. No attempt has been made to group them in any chronological or pedagogical order. This must be determined for each class by its instructor. These exercises are intended to cover one year's work. The practicums do not call for extensive or costly laboratory apparatus. The accompanying photographs illustrate all of the apparatus necessary to carry on most of the exercises.

EXERCISE 1[2]

FIELD STUDY OF VARIATIONS BY MAKING AN HERBARIUM OF VARIATIONS

Have each student collect, press, and mount fifty variations of plants. This is an excellent exercise, for it calls the student's attention very effectively to the vast amount of variation in wild and cultivated plants. This exercise will consume several laboratory periods.

Material. A botanical collecting case, 20 blotters, 50 mounting sheets, labels, and glue.

The accompanying photographs represent specimens treated as above. The following directions may be given to each student.

DIRECTIONS FOR COLLECTING, PRESSING, AND MOUNTING AN HERBARIUM OF VARIATIONS

1. Search for fluctuations, plateations, mutations, and bud variations of plant characters which have been discussed in the lectures.

2. Collect as nearly the whole plant as practicable. The size of the mounting sheets is 11 by 16 inches. When you collect your specimens plan upon this size of sheet, and arrange them accordingly when you are putting them into the blotters.

3. Do not mount large, woody branches showing different degrees of thorniness, etc., upon the mounting sheets, but preserve them in bundles properly labeled.

4. If you wish to show variations of berries, such as thorn apples, etc., dry the fruits and fasten them to the mounting sheets by threads.

5. Leave specimens in the blotters until they are thoroughly dry. If you do not have enough blotters, take out the specimens which have been in the blotters for a week or so, and put them between pieces of newspapers, under pressure, until they become thoroughly dry. Then dry your blotters near a radiator and put in the fresh material.

[2] Credit is due to Dr. H. J. Webber for the original suggestion of this valuable method of studying variations in the field.

FIG. 2—SPECIMEN SHEET FROM HERBARIUM OF VARIATIONS,

Intended to show variation of leaves of the common horseradish. The data on the label record the fact of the name; locality where found, ravine on hillside; habitat, rich protected regions; description of variation, leaf finely divided; class of variation, fluctuation; collector, etc.

6. After the specimens have become thoroughly dry, stick them to the mounting sheets, preferably with glue, but photo paste may be used. Put a small band of adhesive tissue over the larger stems. Arrange the specimens, if possible, so that you have at least one variation on a sheet.

7. Put the label on the *lower right hand corner*, leaving a small margin. Attach the label to the mounting sheet with glue or paste, putting it only on the left edge of the label, that is, do *not* cover the back of the label with paste or glue.

Sample of label

HERBARIUM OF VARIATIONS

DEPARTMENT OF PLANT BREEDING NEW YORK STATE COLLEGE OF AGRICULTURE

Name.....

Locality..... Date.....

Habitat.....

Description of variation.....

.....

Class of variation.....

Collector..... No.....

8. Before the specimen is handed in fill in as many of the blank spaces on the label as possible. Fill in your name after the word "Collector." Fill in both the scientific and common names.

9. *Absolute neatness* is essential.

EXERCISE 2

STUDY OF THE MORPHOLOGY OF DIFFERENT KINDS OF FLOWERS

Object. To acquaint the student with floral parts and their functions. To determine the proper condition of the buds and flowers for emasculation, crossing, etc.

Material. Buds and flowers of various kinds and in different stages of development, microscope or hand lens, set of dissecting instruments.

Have the students make careful drawings of the floral organs.

The following outline by Mr. M. J. Dorsey may be found helpful in this exercise.

Study of Flowers (prerequisite to crossing)

Outline for general study of flowers:

Flower—

Non essential organs—

Calyx—composed of sepals.

Corolla—composed of petals.

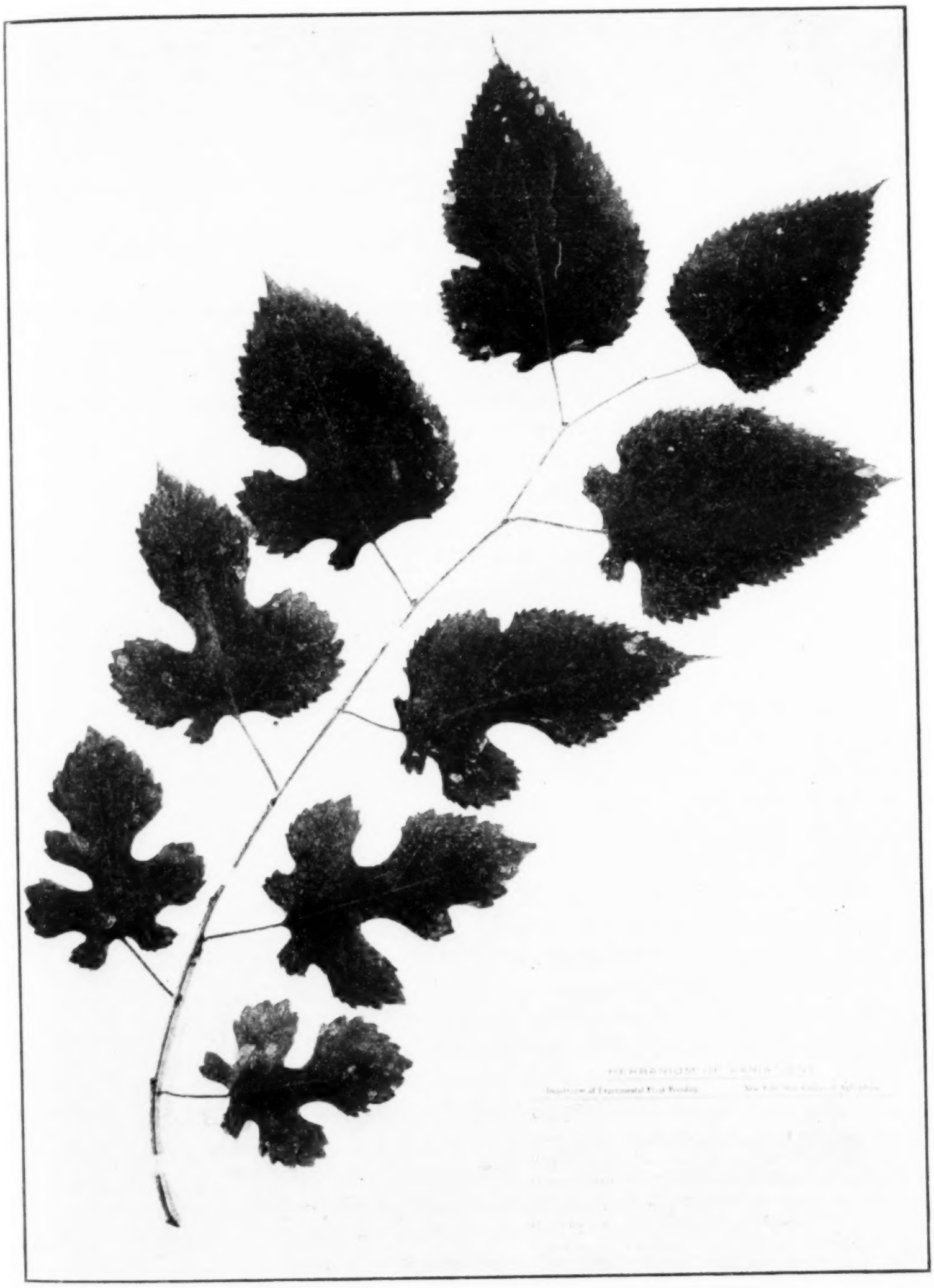


FIG. 3.—SPECIMEN SHEET FROM HERBARIUM OF VARIETIES.

Purpose is to show variations of leaves of the white mulberry. The data on the label record the name; location, campus; habitat, escaped from cultivation; description of variation, margin of leaves varying from entire to deeply lobed; class of variation, morphologic; name of collector, etc.

Essential organs—

Pistil—composed of a, style; b, stigma; c, ovary { carpels. placenta. ovules.

Stamens—composed of a, filament; b, anther { loculus or cell. pollen.

Degree of cross-relationship—

1. Self- or close-fertilization. (Occurring in perfect or hermaphrodite flowers.)
2. Cross-fertilization. (Between individuals of same species or variety.)
3. Hybridization. (Between species and sometimes between varieties which are very distinct.)

Causes of sterility—

1. Stamens and pistils maturing at different times. (Dichogamy.)
2. Lack of affinity between pollen and stigma.
3. Scanty or insufficient pollen.
4. Lack of viability of pollen.

Relative position between stigma and anthers—

1. Stigma and anthers the same height.
2. Stigma above anthers.
3. Stigma below anthers.

Relative maturity of pistil and anthers—

1. Both maturing at same time.
2. Stigma matures first.
3. Anthers mature first.

Methods of fertilization—

1. Insects.
2. Wind.
3. Self-fertilization.

Types of plants with respect to sex—

1. Monœcious (both sexes on same plant).
2. Diœcious (each sex on different individuals within the species or variety).

Types of flowers with respect to sex—

1. Imperfect (1) Staminate—bearing only stamens.
   (2) Pistillate—bearing only pistils.
2. Perfect or hermaphroditic—bearing both stamens and pistils.

Determine the following:

(a) Number of parts to flower—
   a, sepals; b, petals; c, stamens; d, pistils.
(b) Type of flower—perfect (hermaphrodite) or imperfect.
(c) Relative position of stigma and anthers.
(d) Relative maturity of pollen and stigma.
(e) Is the flower fertilized by insects, wind, or selfed?
(f) Draw the essential organs and label each part.

EXERCISE 3

TECHNIQUE OF THE CROSS-POLLINATION OF PLANTS

This exercise may be carried out in the winter in a greenhouse or conducted in the fall and spring out of doors, where additional expense is not involved in growing the plants under glass.

The following suggestive directions may be given to each student.[3]

Pollination or crossing of plants

"Pollination is the act of conveying pollen from the anthers to the stigma."
—Bailey.

Materials: 1. Instruments: Tweezers, scalpel, small sharp-pointed scissors, etc.
2. For covering flowers: Manila bags, waxed paper bags, cheese cloth, etc. Wire labels, stringed tags, etc., may be used to fasten the bags.

Preliminary study of plant:

Before attempting to cross plants, it is necessary to know the structure of the flower to be used. To do this (A) locate all parts—sepals, petals, anthers, filaments, stigma, style, ovary; (B) determine whether the flowers are perfect or imperfect; (C) learn to recognize the "ripe" or receptive condition of the stigma and pollen.

Technique:

(A) Emasculation. (Unnecessary where stamens and pistils are borne on different flowers.) For crossing purposes select flowers in which the anthers have not opened. Remove the anthers with tweezers or scalpel, taking care not to injure the stigma. It may be necessary to remove part or all of the petals in some flowers in order to get at the anthers, but it is best to remove only the anthers, if possible.

(B) Bagging. After the anthers have been removed, the flower should then be covered with some material, as a manila or oil paper bag, to prevent the entrance of foreign pollen. When the stigma is receptive, remove the covering, pollinate with the desired pollen of known purity, and immediately cover again, leaving cover on until fertilization has taken place—as indicated by withered or brownish stigma. It is desirable to remove the covering when the cross has "set."

(C) The record. The record should include a description of each parent form, giving particular attention to the contrasted characters. Colors may be recorded by comparing with a standard color chart. The female parent should always be mentioned first. The record on the label should include variety name or number of each parent, date of emasculation, and pollination. (Name of worker can also be placed on the label.) As far as possible reciprocal crosses should be made.

EXERCISE 4

FIELD STUDY OF EAR-TO-ROW TEST OF CORN

This exercise should be conducted in the fall, and the corn may be either left standing in the rows where it grew or cut and shocked, each row being kept separate.

[3] The writer wishes to give credit to Mr. M. J. Dorsey for some of the suggestions appearing in this exercise.

Object. To test the transmitting power of individual ears of corn.

Material. Small plat of corn, standing or in shock, planted by ear-to-row method; baskets and scales.

Have each student fill in the following form for each row:

Row Number.	Height in feet.	Number of stalks.			Number of ears.		Total yield in pounds.	Yield per stalk.	State of maturity.	Remarks.
		Eared.	Barren.	Total.	Good.	Poor.				

EXERCISE 5

LABORATORY STUDY OF EAR REMNANTS OF KNOWN PERFORMANCE

In the preparation of Exercise 4, one-half of each of the parent ears should be saved for this exercise, and the other half planted.

Object. To study the correlation between ear type and ear performance.

Material. Half ears of corn, each numbered, and the data from their corresponding rows as obtained in Exercise 4.

FIG. 4.—APPARATUS FOR CROSS-POLLINATION.

Set of instruments, bags, string, notebook, and a copy of the standard color book, "Repertoire des Coleurs," for accurately describing the color of flowers, etc.

EXERCISE 6

STUDY OF TUBER UNITS OF POTATOES

This exercise should be conducted in the field in the fall. The potatoes should have been planted by the four-hill-unit system, that is, each four hills having the same progeny number should come from the same mother tuber, and they should be so planted and staked that the progeny of the seed end or apex of each mother tuber may be distinguished from the progeny of the base or stem end.

Object. (a) To test the transmitting power of individual potatoes. (b) To test the yield of base and apex.

Material. Small field of potatoes planted by the tuber-unit system, previously dug and each hill replaced where it grew but exposed to sight; sets of scales.

Have each student fill in the following form for each hill:

Progeny number									
Parent number									
Seed from stem end or seed end									
Total weight of hill									
Weight of marketable tubers									
Percentage of marketable tubers									
Total number of tubers									
Number of marketable tubers									
Average weight of tubers									
Shape									
Regularity									
Color									
Depth of eyes									
Amount of disease									

EXERCISE 7

FIELD TRIP TO EXPERIMENTAL GROUNDS

Most experiment stations have plant-breeding experiments under way, and if a fall inspection of the plats would be instructive to students they should be taken on such a trip early in the fall and required to make careful notes.

EXERCISE 8

LABORATORY STUDY OF VARIATION IN POTATOES

(a) Students should make up a score card for potatoes to fix in mind ideals towards which to breed. (b) A careful study should be made of the data obtained from Exercise 6. (c) Hills of potatoes weighing $\frac{1}{2}$, 1, 2, $2\frac{1}{4}$, $2\frac{1}{2}$, 3, and 4 pounds should be made up and drawn natural size, in notebooks.

Objects. (a) To gain a better knowledge of potatoes. (b) To study their variation statistically. (c) To fix in mind how hills of different weights look. (d) To calculate the theoretical yields per acre with certain weights per hill.

Materials. Ten potatoes to each student; data from Exercise 6; scales; a few bushels of potatoes.

The following outline may be used:

1. Make score card for potatoes.
2. Total weight of ten tubers.
3. Average weight per tuber.

4. Make up hills weighing $\frac{1}{2}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, 3, and 4 pounds. Draw each natural size.

5. Compute yields per acre from above weights per hill, assuming the hills were planted in rows 3 feet apart and 18 inches in the row.

EXERCISE 9

CORN JUDGING

Students of plant breeding should be trained to have a critical judgment of agricultural and horticultural plants. Exercises in comparative judging are the best way to attain this end. Utility should be kept constantly in mind.

Details of corn judging will not be given here; they are too well known to need emphasis. For the east, both dent and flint varieties should be used. The ears which are judged in this exercise may be saved for Exercise 10, which should always accompany Exercise 9.

Object. To encourage critical judgment of corn and, by the same means, of other crops.

Materials. Ten ears of different races and types of corn to each student; tape, scales, charts, etc.

Each student should score sample of flint corn according to the following score card:

New England Flint

	Points
Maturity and seed condition	20
Uniformity (or regularity of single ears)	15
Kernels	15
Weight of ear	10
Length and proportion	10
Tips	5
Butts	10
Sulci (space between rows)	10
Color	5
Total	100

EXERCISE 10

STATISTICAL STUDY OF EARS OF CORN

This should accompany and follow Exercise 9.

Object. (a) To study critically and statistically the various parts of ears of corn. (b) To work up these data by biometrical methods, drawing curves, and ascertaining mean, standard deviation, coefficient of variability, etc., for the various parts of the ear. (c) To illustrate testing for germination.

Materials. Each student should be given the same ears of corn which he had for Exercise 9; tapes, scales, and germinators of various kinds suitable for testing corn.

The following form should be filled in by each student:

Study of Corn.

Variety: **Dent, flint, sweet, pop. (Underline.)**

Where grown									
(a) Length of ear in cm.									
(b) Circumference of ear in cm. ($\frac{1}{3}$ butt to tip)									
(c) Weight of ear									
(d) Number of rows									
(e) Circumference of cob ($\frac{1}{3}$ butt to tip)									
(f) Weight of shelled corn									
(g) Weight of cob									
(h) Percentage of shelled corn									
(i) Total number of kernels									
(j) Average weight of kernel									
(k) Width of kernels in cm. (taken at random)									
(l) Compute average width.									
(m) Length of 50 kernels in cm. (taken at random)									
(n) Compute average length									
(o) Dissect kernels—where does the color lie?									
(p) Draw typical kernel (side view) natural size									
(q) Make germination test									

EXERCISE 11

STUDY OF CORRELATIONS OF CHARACTERS IN CORN

Use the same data as employed in Exercises 9 and 10. Make correlation tables by accepted biometrical methods, of such characters as length and circumference; length and number of grains; weight and number of grains; length and weight; etc. Work out correlation coefficients.

Object. To find out if certain characters are associated so that a measurement of one will give an indication of the other.

Materials. Data from Exercises 9 and 10; cross-section paper.

EXERCISE 12

STUDY OF VARIATIONS IN PRESSED SPECIMENS OF RAGWEED, OR SOME PLANT SHOWING MANY DIFFERENT TYPES

Object. Careful study of the large and small variations between different biotypes of ragweed (*Ambrosia artemisifolia*).

Materials. Specimens of many different types of the above plant or any kind of plant which is rich in biotypes. These specimens should be carefully pressed and mounted. Have each student make detail drawings showing minute differences.

EXERCISE 13

STATISTICAL STUDY OF APPLES FROM DIFFERENT TREES

Object. To study the individuality of fruit trees.

Materials. Apples representing the total product of different trees; scales; calipers.

Fill in the following form for each tree. Plot curves representing the entire population of trees.

Name of variety										
Tree No.										
Age of tree										
Condition of tree										
Total number of apples										
Number of marketable apples										
Total weight of apples										
Weight of marketable apples										
Average width of 50 apples										
Average length of 50 apples										
Color										
Any other noticeable differences										

EXERCISE 14

STATISTICAL STUDY OF BRANCHES OF DIFFERENT TREES

Object. To continue the study as outlined in Exercise 13 to test the individuality of trees.

Materials. Fruit trees of different kinds, dwarf trees preferable; tapes.

Measure the new growth of various parts of each tree and of different trees. Plot curves of each tree and of all of the trees as a population, thus showing graphically the extent of bud variation present.

EXERCISE 15

STUDY OF OAT AND WHEAT HYBRIDS

Object. To study Mendelian dominance, segregation, and recombination of characters in second-generation oat and wheat hybrids.

Materials. First and second-generation oat and wheat hybrids. These should be chosen so that the parents have conspicuous differentiating pairs of characters. For example, black and white grains in oats and bearded and beardless types of wheat.

Give each small group of students several bundles and have them count the various types. Put all of these counts together and compare them with theoretical Mendelian ratios.

EXERCISE 16

STUDY OF CORN HYBRIDS

Object. (a) To determine the unit characters of corn and their behavior in transmission. (b) To study the immediate effect of pollen, or Xenia, in corn.

Material. Provide first and second-generation hybrid ears of corn with various known types of parentage.

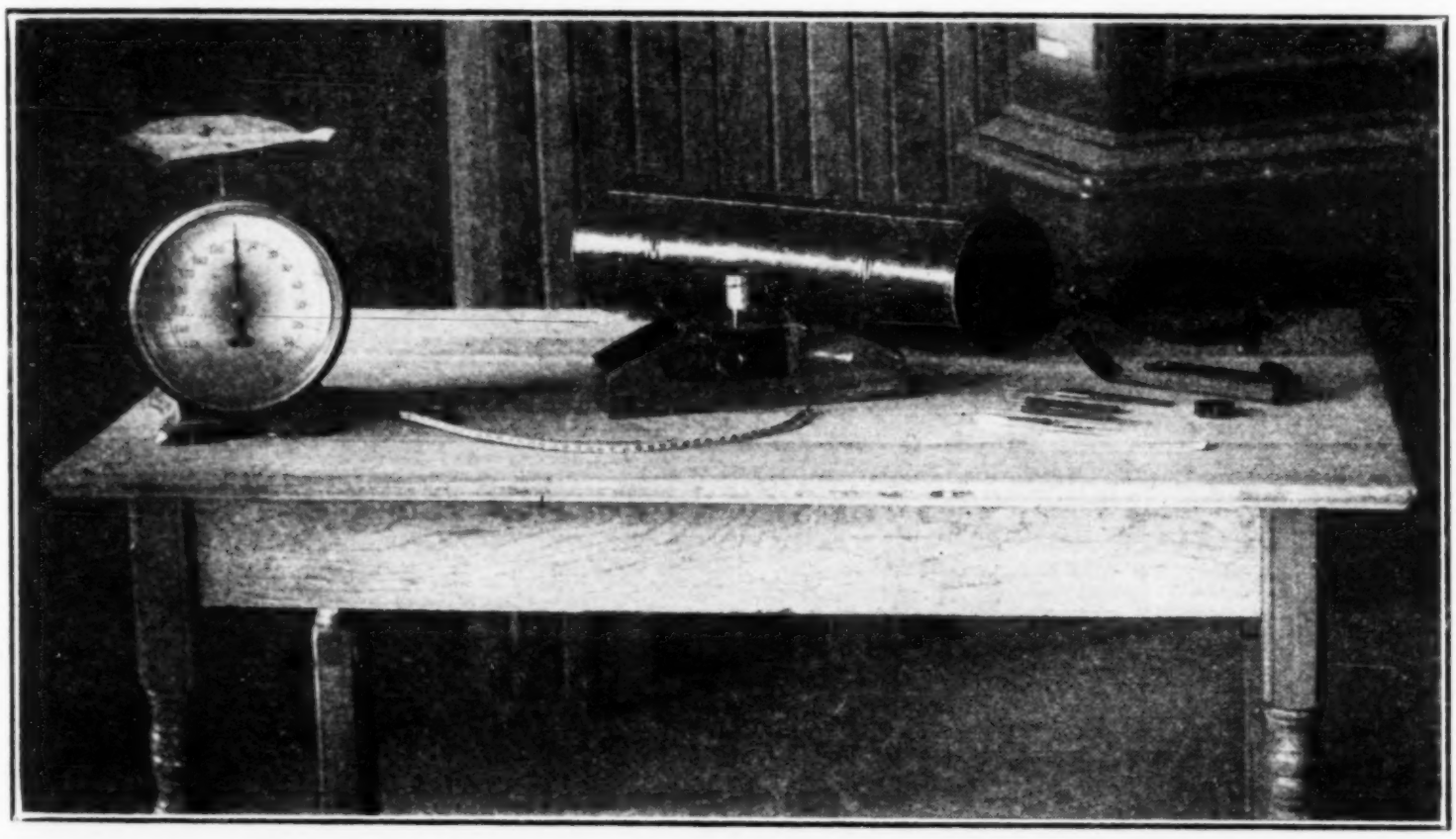


FIG. 5.—SAMPLE APPARATUS FOR CONDUCTING PLANT-BREEDING EXPERIMENTS.
Most of the experiments here described can be carried out with this equipment.

Have each student study the kind and position of the color in a kernel of corn and trace the behavior of these colors throughout the two generations. Trace also any other factors which may appear to segregate during transmission. Count the dominant and recessive characters and determine their number as compared with theoretical Mendelian ratios.

EXERCISE 17

STUDY OF CITRUS HYBRIDS

Object. (a) To study the possibility of obtaining valuable kinds of citrus fruits by means of hybridization. (b) To study the structure of citrus hybrids as compared with their parents. (c) To study the economic value of these hybrids.

Materials. Obtain from some of the extreme southern experiment stations, or from nurserymen or growers, samples of citrus hybrids, such as citranges,

tangelos, and the like, and samples of *Citrus trifoliata*. Purchase oranges, lemons, grapefruits, and tangerines from the fruit stores. Provide also for each student, or group of students, a glass, spoon, sugar, and water.

Compare the hybrids with their parents, with special reference to the following points:

(a) *Fruit*—size, shape, color, amount of juice, quality of juice, condition of segments, etc.

(b) *Trees* (if branches or photos are available)—size, shape, branching, kind of leaves, etc.

(c) *General*—length of season, resistance to cold, etc.

Squeeze out the juice from several fruits, add sugar and water, and test the adaptability to beverage and other economic purposes.

EXERCISE 18

ILLUSTRATION OF THE APPLICATION OF THE LAW OF CHANCE

Object. To demonstrate how such ratios as 3 : 1; 9 : 3: : 3 : 1, are the result of the laws of probability.

Materials and Methods to illustrate the union of gametes where one pair of characters is concerned:

(a) Provide a closed vessel containing black and white beans of the same size and shape; or,

(b) Provide a pack of playing cards.

Draw at random two beans or two cards at a time. Record each combination observed. Two blacks coming simultaneously illustrate a homozygous black individual; a black and a white represent a heterozygous form appearing as black; and two whites illustrate a pure recessive.

Materials and Methods to illustrate the union of gametes where two pairs of characters are concerned.

(a) Provide a closed vessel containing yellow and white kernels of both flint and dent corn of as near the same size and shape as possible. Here we have illustrated gametes representing four combinations of characters as follows: Yellow flint, yellow dent, white flint, and white dent.

Draw at random two kernels at a time. Record the visible types of individuals which each combination of gametes would produce, assuming yellow dominant over white, and flint dominant over dent. The theoretical ratio would be 9 yellow flint : 3 yellow dent : : 3 white flint : 1 white dent.

Similarly two packs of cards having different kinds of backs may be used and assume one kind dominant over the other. Shuffle all together and draw two cards at a time.

EXERCISE 19

STUDY OF BUD VARIATIONS AND REVERSIONS IN FERNS

Object. To determine the nature and amount of reversion from the parental type, and if possible to find some cause for the same.

Material. Obtain specimens of the sword fern (*Nephrolepis exaltata*) and Boston fern (*Nephrolepis bostoniensis*) and as many of the other ferns named below as possible.

Study the trueness to type of each variety and any reversions which they may contain. Draw typical specimens.

The following is the history, according to Dreer, of some of the fern varieties:

	Introduced in	Sport of—
Nephrolepis bostoniensis	(?)	Nephrolepis exaltata (Sword Fern)
Nephrolepis piersoni	1903	bostoniensis.
Nephrolepis elegantissima	1904	piersoni.
Nephrolepis scotti	1904	bostoniensis.
Nephrolepis barrowsii	1905	piersoni.
Nephrolepis whitmani	1906	barrowsii.
Nephrolepis todeaoides	1907	whitmani.
Nephrolepis superbissima	1908	bostoniensis.
Nephrolepis scholzeli	1909	scotti.
Nephrolepis pruessneri	1909	whitmani.

EXERCISE 20

DRAWING MAPS OF FARMS SHOWING THE LOCATIONS OF BREEDING PLATS AND THEIR RELATION TO THE REST OF THE FARM

Object. To demonstrate methods whereby plant-breeding trial plats may be made to articulate with the layout of fields for ordinary farm operations.

Materials. Outline maps of certain farms showing the layout of fields and the methods of rotation.

Sketch testing plats in convenient places where the soil is uniform. Determine the amount of land necessary for a potato-breeding plat, a corn-breeding plat, etc. Place the corn-breeding plat at a safe distance from the general field of corn.

EXERCISE 21

PRACTICE IN THE CROSS-POLLINATION OF APPLES, PEARS, PEACHES, PLUMS, ETC.

To be carried on in the spring, when the trees are in blossom.

For general methods of procedure see Exercise 2.

EXERCISE 22

STATISTICAL STUDY OF THE AMOUNT AND QUALITY OF GRAPES FROM DIFFERENT GRAPE VINES

Use the same general method as in Exercise 12.

EXERCISE 23

STUDY OF THE RESULTS OF THE PLANT-TO-ROW TESTS OF WHEAT, OATS, CABBAGE, ONIONS, OR ANY CROP WHERE DATA ARE AVAILABLE

See Exercise 3.

EXERCISE 24

EMBRYOLOGICAL STUDIES FROM SLIDES SHOWING CELL DIVISION AT DIFFERENT STAGES, CHROMOSOMES, POLLEN MOTHER CELLS, OVULES, ETC.

Provide each student with a high-power microscope and microscopic slides mentioned above. Careful drawings of each slide should be made.

EXERCISE 25

STUDIES OF ORIGIN OF VARIETIES—CORN, WHEAT, APPLES, PLUMS, GRAPES, ETC.

Literature study of the history of varieties. Methods employed to originate varieties should be carefully noted.

THE CORN BREEDER'S PROBLEMS

C. P. HARTLEY,
U. S. Department of Agriculture, Washington, D. C.

It was many years after wonderful results had been accomplished in breeding fruits and flowers that attention turned to our most valuable plant—corn. Of recent years by numerous means the great value and possibilities of this crop have been brought to the attention of the public. Good results have been accomplished, but not to the extent expected, considering the general appreciation of the value and possibilities of the crop. This is due to the small amount of careful and persistent field work that has been done.

Now that the possibilities of corn improvement have been so fully published, some are turning their energies to field work in attempts to accomplish this improvement. The actual doing of this work has brought out many problems, making the work more complex than was at first supposed. These problems call for more determined and persistent effort. The enormous returns that will follow an increased yield of one bushel of corn for every acre planted have been too fully expounded to allow complexities to prevent accomplishment. Corn breeders must make good. The field work must be done, and to do it properly fundamental principles of corn improvement must be established, and methods of making field tests so improved that they will be reliable.

Until recently the accomplishment of results has been expected of the farmer, and he has accomplished about all that has been done, but it is now evident that corn breeders have duties that can not be shifted upon the busy farmer. Ranchmen have adopted and propa-

gated improved breeds, the product of years of careful work of skilled animal breeders. Farmers will readily adopt and propagate improved and adapted strains of corn as soon as corn breeders originate them and demonstrate their superiority.

The fact that the various strains of corn of a neighorhood when comparatively tested as to productiveness show differences of 5 or 10 bushels per acre is sufficient proof that corn breeders should determine the causes of these differences and perfect methods whereby farmers may be supplied with seed of the highest yielding strains.

Division of corn-breeding work.—Great undertakings along any line require careful planning of the work, and a division of the tasks involved. The various features of corn breeding have a bearing upon the profits of almost every farmer of the country. But the necessary work has not been sufficiently well planned nor its various tasks sufficiently well allotted to various grades of workers. The task naturally divides into two principal parts—(1) the determination of causes influencing improvement; this is the investigator's work; and (2) the practical application of methods producing improvement; this is the corn breeder's work. These two lines of corn-improvement work are distinct. Each needs a specially trained corps of workers. The results obtained by the one will help the other, and working together they can provide the farmer with seed of much more productive strains than his own ability or facilities enable him to produce.

The investigator's problems.—The care of the corn crop is such a universal line of work that there naturally exists the general impression that it embodies no difficult problems. This impression is soon removed from the mind of the investigator attempting to determine, why some strains are more productive than others. His investigations reveal numerous factors simultaneously exerting influences the effects of which he would like to consider singly but is forced to consider collectively.

The corn breeder who is desirous of making his business profitable as well as of benefit to his neighbors can not be expected to determine, for instance, the effects that will result from changes of environment, the best methods of utilizing the effects of adaptation and acclimatization, the relative values of centgener selection and of cross-breeding and their best combinations, the comparative value of different test-plat methods, the effects on productiveness of preserving seed corn under different degrees of temperature and humidity—and yet these questions have a vital bearing upon the success of his business.

The practical breeder can make separate germination tests of every

ear of seed corn he sells, and guarantee 98 or 99 per cent of the kernels to germinate, but it is a problem for the scientific investigator to determine whether there is really any relation between the percentage of germination and productivity. To be sure, it is very generally taken for granted that seed that germinates 99 per cent is more productive than seed of the same strain that germinates but 50 or 60 per cent, yet very careful tests have shown that the productivity of seed corn may be greatly reduced by exposure without reducing its germinating power. Other tests have shown that seed corn four or five years old, and of which but 50 or 60 per cent of the kernels would germinate, produced as well per acre and per plant when sufficient seed was planted to obtain a perfect stand as one-year-old seed of the same strain which germinated 98 per cent or better. Is it a question of the early death of kernels of low producing power and the survival of those having vigor and highest yielding power, or did the kernels outlive attached germs of disease that grow with and reduce the producing power of the plants?

Seed corn that germinates 99 or 100 per cent at maturity with proper preservation will hold its vitality four or five years, while that which germinates but 70 or 80 per cent at maturity will lose most of its vitality within a year or two.

Practical seed-corn dealers often find artificial heat beneficial in keeping seed corn dry, but investigations may prove that a low temperature and dryness will better retain its producing power. Do the warm, humid winters of the South reduce the producing power of seed corn more than the cold and dry winters of the North? Why is seed corn grown during a certain season or on a particular soil of higher yielding power than seed of the same breeding grown during other seasons or on other soils?

These problems are numerous and complicated and their successful solution calls for a perfecting of methods, carefully drawn plans for the solution of each problem, and then the execution of the plans with as much precision, and by as intelligent investigators, as those who solve problems of chemistry or astronomy. Results of test-plat work will continue to be unreliable if the field work is delegated to unreliable workers.

Reliable methods must be originated and standardized.—Without test-plat methods the results of which can be depended upon, neither the investigator nor the practical breeder can measure the results of his efforts or know what he is doing. Neither can he who casts aside all test-plat work as worthless and resorts to theorizing regard-

ing generalities render assistance in originating more profitable strains of corn. Generalities are valuable for some purposes, but living, growing plants present so many exceptions to general laws that each case must be tested to determine whether it is a conformation or an exception. Furthermore, it is often the exceptional variety or individual which brings most profit to the breeder.

The need is not for methods of finer discrimination but for reliable methods. The problem is not one of finding the seed ear that produces most pounds and ounces, but one of finding methods that prove the increased productiveness to be inherent and not due to differences of soil, of moisture, of heat, of space, or of seed preservation, or to any other factor than the one under investigation.

Another way of rendering results reliable is by making the tests a large number of times under conditions as nearly identical as possible, considering the problem unsolved until every test gives the same result or permits of otherwise satisfactory explanation.

There is no better means of establishing the reliability of methods of breeding than by submitting them to the experienced members of the American Breeders Association for criticism, amendment, and adoption. To avoid generalities just referred to and institute a step toward the adoption of standard methods, one is here submitted for testing the relative productiveness of different varieties of corn requiring similar conditions for growth and productiveness, and for testing the relative productiveness of different ears of a variety. In either case the method is essentially the same.

Among fourteen first-generation crosses, the productiveness of which was tested in 1910 in comparison with the parent varieties, three were found more productive than either parent; to be concise, one to the extent of 19 per cent. The method illustrated in the diagram below will be used in testing the relative productiveness of 100 ears of this advantageous cross, that remnants of the highest-yielding ears may furnish seed for a breeding plat.

The test plat will be marked off in both directions and planted with seed of the cross by the ear-to-row method in one direction (shown in diagram as seed 1, 2, 3) and with alternate rows of the two parent varieties by the ear-to-row method in the other direction (seed A, B, A, in diagram). Sufficient seed from each of two ears will thus be planted in each hill to permit thinning so that each hill will contain, on the west for instance, a stalk of the cross and six inches to the east a stalk from an ear of one of the parent varieties.

At harvest two men work together, one gathering the yield from

the cross in row 1 at the time the other gathers the yield from the parent varieties, A, B, of the same row, only perfect hills, i.e., hills containing one normal stalk of the cross and one of a parent, being considered. By this method a uniform check grows in each row and the relative productiveness of the 100 ears of the cross is obtained by comparing each with its check. This method reduces the exaggerated superiority of rows which by their unusual thrift gain ascendency, overgrow, and impose upon adjoining rows. A duplication of the entire test can be had by making the rows planted with the cross

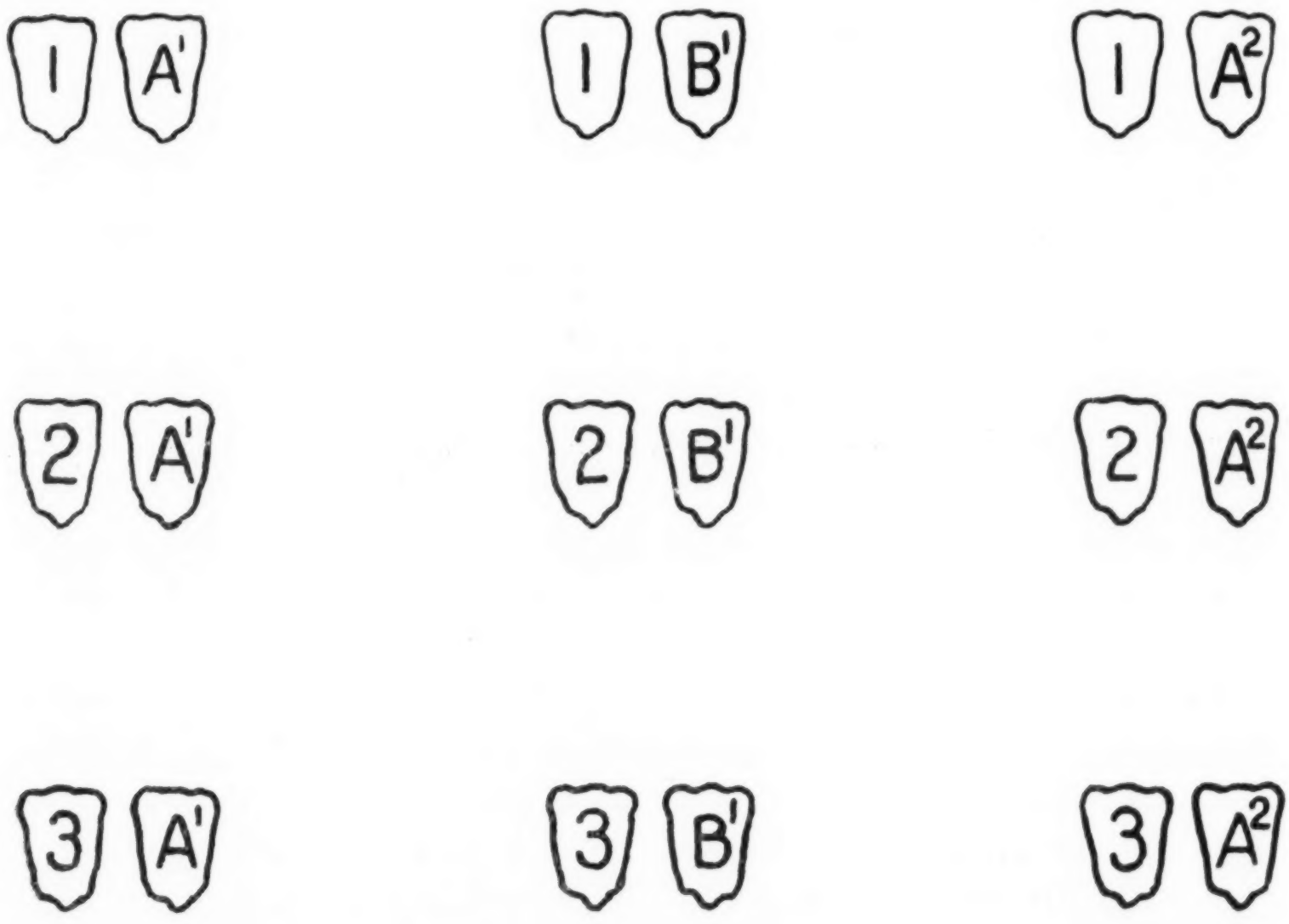


DIAGRAM ILLUSTRATING METHOD OF PLANTING BREEDING PLOT OF HIGH YIELDING CORN.
Nine hills in northwest corner of the test plot; grains numbered 1, 2 and 3 represent grains from different ears of the cross; letter A represents one parent, B the other; small figures, as A′, B′, A^2, represent different ears of A and B.

60, 80, or 100 hills long and dividing the plat into two similar halves of 30, 40, or 50 hills to the row.

The practical corn breeder's problems.—The practical breeder's problems are directly connected with the growing, preserving, and delivering of seed corn that will meet the varied needs of corn growers. Local demonstrations of high productiveness will cause ready sales of seed corn. Many of the corn breeder's problems will be simplified by the exercise of good judgment. Corn-breeding work can not be done by machinery—the scales will determine which yields heaviest,

but the heaviest may be the least desirable because of high water content or poor keeping qualities. Forty bushels per acre of ninety-day corn may be more valuable than 60 bushels of a variety maturing so late as to necessitate additional irrigation and cultivation, or prevent using the land for another crop.

The breeder must become familiar with all tendencies and variations of the variety with which he works.

Almost every attempt to solve a problem concerning corn breeding discloses other problems. The purpose of this article will have been accomplished if it has made clear the fact that possibilities in breeding corn have not been approached, and that an adequate attempt to accomplish them calls for—

1. Standardization of methods.
2. A definitely planned system for the solution of each problem.
3. An allotment of the problems according to their complexity to conform to the ability of different breeders.
4. Persistent field work upon a single problem till all influencing factors are sufficiently under control to permit the accomplishment of uniform results.

GEOMETRICAL FIGURES IN PLANT BREEDING

BYRON D. HALSTED

Agricultural College Experiment Station, New Brunswick, N. J.

In working upon some of the breeding factors in peppers, it has been found convenient to use geometrical figures to express to the eye the combinations that have been made.

In the case of (1) the position of the fruit, whether pendent (dominant) or upright (recessive) upon the branch, and (2) the flavor of the fruit, whether pungent (dominant) or sweet (recessive) ("hot" and "mild"), triangles and their derivatives may be constructed that are helpful. The accompanying "16-square," familiar to all breeders, is filled up with these figures.

In order to designate over-lapping, the pollinator is uniformly drawn in solid lines—that is, uppermost—and the embryo sac determinants with broken lines.

In all instances, when the two parental figures are alike in shape and position, the offspring is pure of that figure as shown in the four in the diagonal from square 1 to 16, but, of course, no two of these are the same; thus, 1 and 6 are both hot (sharp-pointed) but the direc-

tion of the point indicates that in 1 the fruit is pendent and in 6 upright. In like manner, in squares 11 and 16 the position is the same for the lower numbers of each pair but the triangle tip is lacking in the last—that is, the fruit is mild.

There are four other squares that bear plain triangles, namely, 3, 8, 9, and 14—that is, two pairs with the common value 5 between

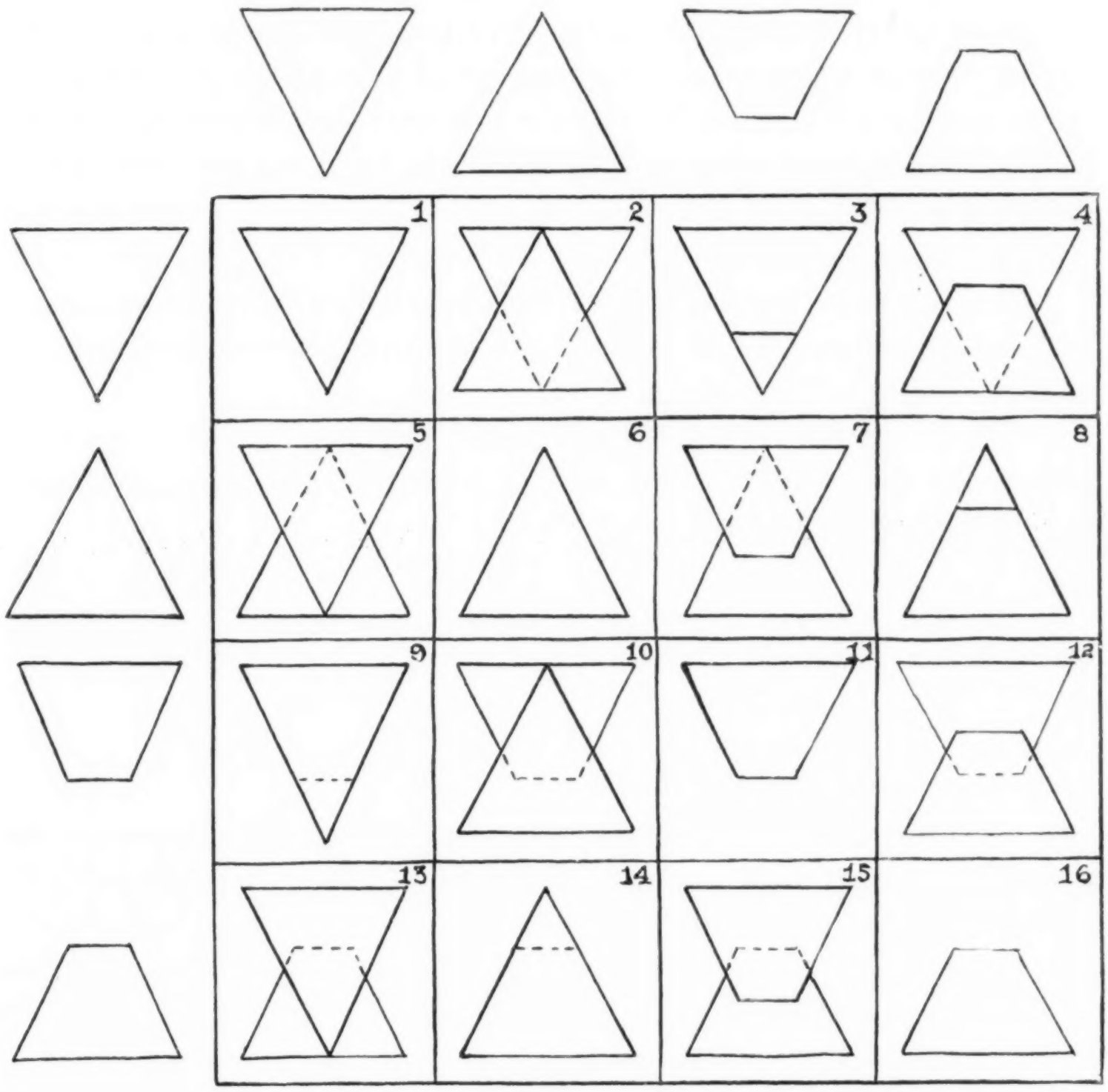


FIG. 1.—A 16-BREEDING SQUARE.

Triangles and polygons replace letters to express the combinations when two pairs of una are represented. The male gametes are figured above and the female at the left.

them and they differ in the direction of the angle—that is, 3 is pendent and 8 upright, while 9 is pendent and 14 upright; but the last two are reciprocals of the first two respectively. That is, 3 and 9 differ in the relation of the parents to the qualities under consideration and this is shown by the solid and dotted short line indicating the mild nature of one parent,—that is, the male parent in 3 is mild

and 9 in the female. The same reciprocal relationship is shown by the same lines for 8 and 14 where both are hot and upright.

The polygons are eight in number, alternating throughout with the triangles, and are grouped as four pairs of reciprocals, thus the ones at 2 and 5 (three being the number of units between them) show that, while both are hot and upright, the dotted lines indicate a difference in the relation of the parents to the una in question. In like manner, 12 and 15 show at once the lack of sharp angles and therefore both are mild and pendent but reciprocals.

In the diagonal from 4 to 13, crossing the other diagonal of the pure offspring, 7 and 10 (with the common difference of three) fill up the cross-lines from 2 to 12 and from 5 to 15 in the chart; and are

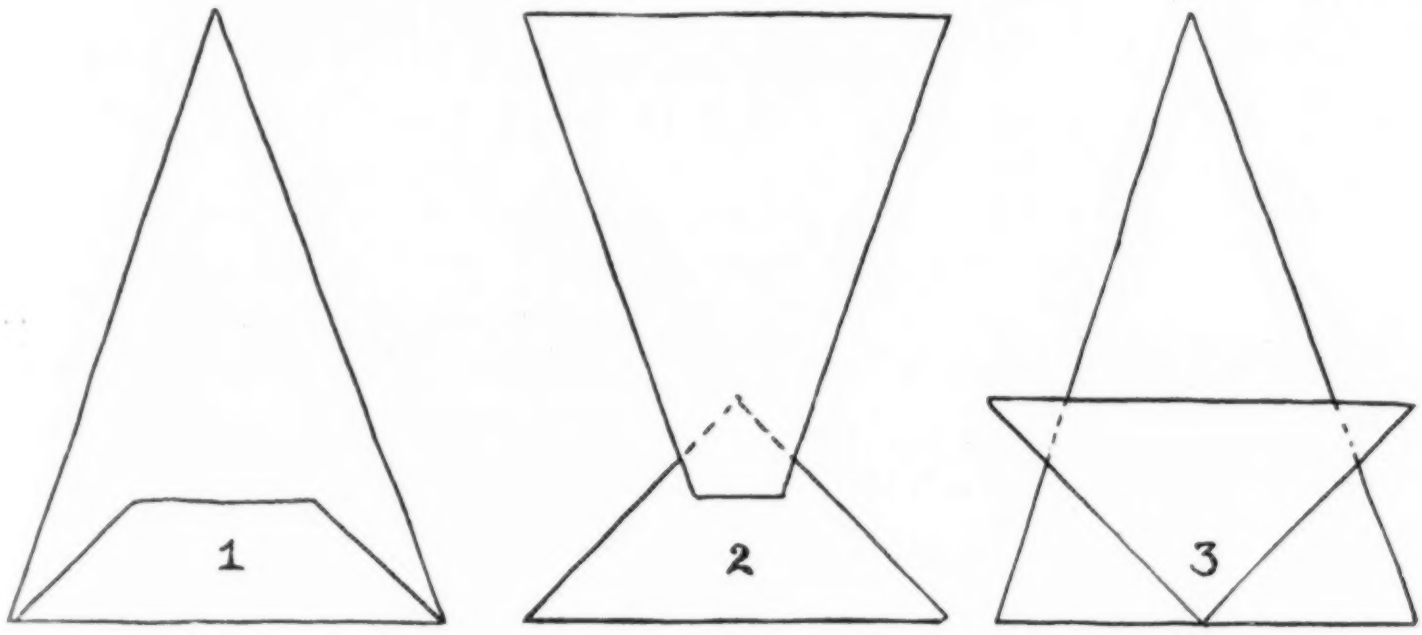


FIG. 2.

At 1, 2, and 3 are geometrical figures used to show different combinations when four pairs of una are involved in the breeding.

reciprocals of the ordinary sort,—that is, without the dominants and recessives both borne by the same parent,—the latter being a rare condition that obtains in the opposite corners,—namely, 4 and 13, where 4 has both recessives brought by the pollen to the dominants in the egg-cell, while in 13 the reverse is true, making this a paired reciprocal.

If one wishes to study certain figures without the confusion that the presence of the others may induce, all but those desired can be quickly excluded by using gummed paper flaps to cover any figures temporarily.

In the case of the peppers, there are the tall and the dwarf sorts and this pair of allelomorphs can be readily accommodated by making two sides of the triangle somewhat prolonged for the tall type.

In 1 the dwarf, upright, sweet, red (color here omitted) pepper is bred upon a tall, upright, hot, yellow sort. The reciprocal of this would be shown by dotted lines for the female parent. At 2 is expressed geometrically that a tall, pendent, sweet, red sort is bred upon a dwarf, upright, hot, yellow variety; and in 3 a dwarf, pendent, hot, red is the pollinator for a cross upon a tall, upright, hot yellow.

The use of symbols in plant breeding is no new thing and doubtless many workers' notebooks show various symbols that do not find their way into print. Mendel employed them freely and whole pages of Bateson's "Principles of Heredity" are literally covered with diagrammatic symbols, especially when pedigrees are visually expressed.

SPERMATOGENESIS, OR ORIGIN OF THE MALE GERM CELLS

L. C. BRAGG and L. B. BRAGG
Fort Collins, Colo.

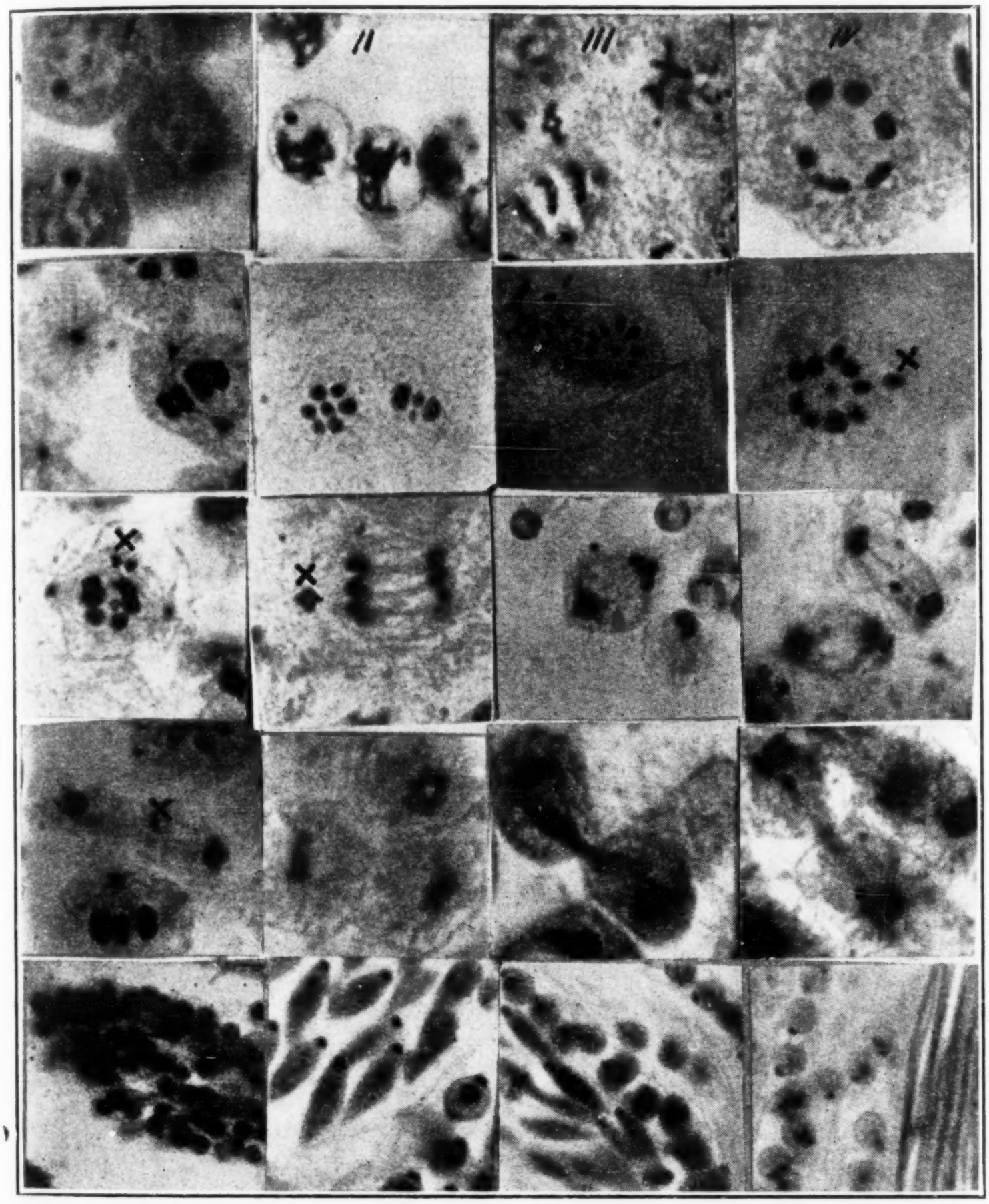
It is a well known fact that all of the higher forms of both animal and vegetable life may be traced back to the union of two cells. In plants, these two cells are designated as the pollen and ovule, in animals, egg and spermatozoon.

We hope to make plain the origin and growth of the spermatozoa of a few common insects by means of the accompanying photographs taken directly from the microscopic slides. The germ cells are early set aside in the growing embryo and are known as primitive sex cells or spermatogonia.

These cells remain dormant till the animal matures. Each cell consists of a nucleus and cytoplasm, as do most cells. The nucleus occupies the center in a membrane of its own.

All resting cells take up stains readily, so that the nucleus may be colored a deep red or black, while the outer layer of cytoplasm may be colored a beautiful green or rose tint. It is by means of these stains that we learn what is taking place during the process of transformation from the spermatogonia to the ripe spermatozoa. What is true of the animal cell is also true of the plant cell. A growing cell must soon divide and produce two. The spermatogonium grows into two spermatocytes; these again divide, forming four spermatozoa, which terminates cell division, so that each primitive cell forms ultimately four spermatozoa.

The nucleus of the growing cell passes through four phases of growth known as the prophase, metaphase, anaphase and telophase. In the prophase, the nuclear material separates into a number of pieces



SUCCESSIVE STAGES IN SPERMATOGENESIS.

First line across top, prophases; second line, metaphases; third line, anaphases; fourth line, telephases; fifth line, spermatids; *x* sex chromosome.

called chromosomes. The nuclear wall breaks down and the chromosomes arrange themselves in a circle at the equator of the cell. This stage of growth is termed the metaphase, and when viewed from the pole of the cell the chromosomes appear as round or rod-shaped bodies forming a circle.

Each chromosome now divides in half and the halves move toward the poles of the cell, forming the anaphase. The final step is the telophase, when they have reached the poles of the cell. A membrane now forms across the equator and the chromosomes become enclosed in a membrane, thus forming two daughter cells in the resting stage.

The chromosomes have come together and there is nothing to show their identity except in the metaphase, where they vary much in size and shape. One of these has been called the sex or X chromosome because in many animals the male never has this element but the female does. This gives all cells of the female one more chromosome than the male possesses in all of the somatic or body cells.

THE PRACTICAL BREEDING OF "FIRST-EARLY" MARROWFAT PEAS

WALTER F. GILES
Hazeldine, Reading, England

To the raising of new types of garden peas there seems no end, but although the list of commercial varieties is now extremely large, it is hardly probable that the limit of improvement has yet been reached.

Year by year patient workers are endeavoring to breed something better than has hitherto been produced, by combining in a new plant the good points of the older ones, and available records show that in attempting to add earliness to the delicious marrowfat or wrinkled-seeded peas, success has been even greater than might reasonably have been expected.

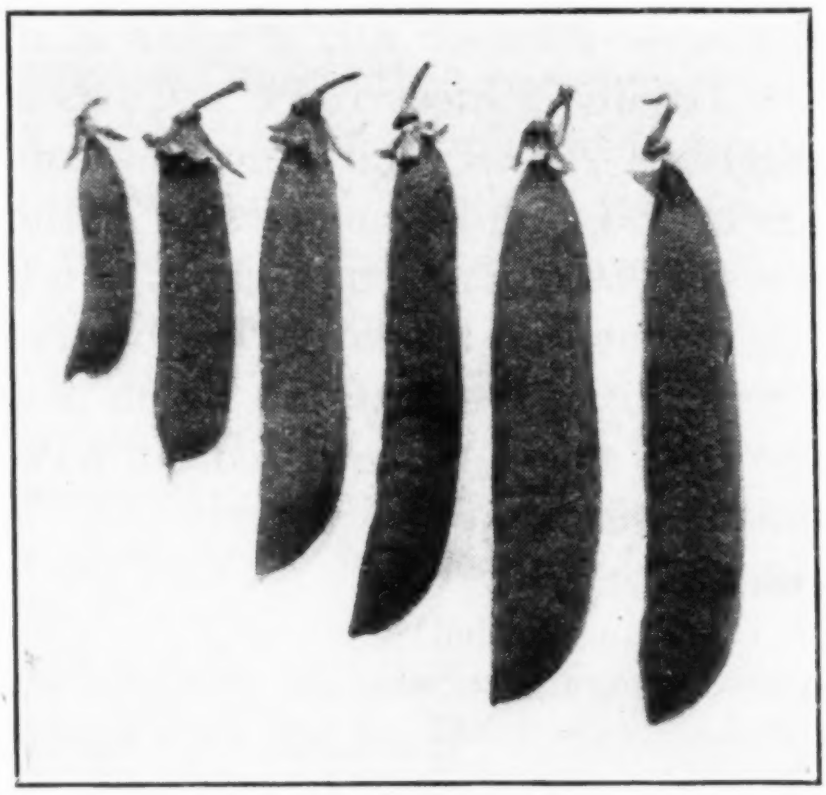
Until the early part of the nineteenth century, the garden peas in general use in England appear to have been of the round-seeded class, but as a result of some experiments in crossing carried out by Thomas Andrew Knight (a former president of the Royal Horticultural Society) one or two wrinkled types were introduced into commerce.

These new wrinkled-seeded peas, although not early nor very large in the pod, possessed a much richer flavor than the old round-seeded kinds, and came to be known as "marrowfats."

Naturally it was not long before other breeders were in the field endeavoring to improve upon Knight's introduction, with the result that many new forms with larger pods and dwarfer habit of growth were brought into cultivation. One valuable feature however which was still lacking in these improved types was earliness. None of

them would mature so quickly as some of the round-seeded kinds, and consequently the delicious marrowfats could only be enjoyed comparatively late in the season.

However, to Sutton's, of Reading, England—whose achievements in peas are so well known—there appeared to be no reason why, by judicious crossing, varieties should not eventually be obtained which combined the large fine pods and flavor of the marrowfats with the earliness of the round-seeded kinds. Accordingly experiments to attain this end were taken in hand, and as a result they were able in 1891 to commence the introduction of a class of large-podded early



TYPES OF PEA PODS.

At extreme left a pod of one of the early round-seeded peas. Remaining pods are types obtained by crossing, and which are as early or earlier in maturing as the early round-seeded pea, and in addition are wrinkled in the seed.

wrinkled peas hitherto unknown in horticulture. The first to be offered was Empress of India. This resulted from a cross between Early Champion (an early round-seeded pea) and Telephone (a main crop wrinkled variety).

A pea which was subsequently made much use of as a parental form was American Wonder. This very dwarf-growing early wrinkled pea was first introduced in America about 1878 or 1879 by Messrs. Bliss of New York and was said to be the result of a cross between Champion of England (a rather late wrinkled-seeded variety) and Little Gem (a dwarf fairly early wrinkled sort).

The American Wonder proved to be earlier than either of its parental forms, and was thought so much of by Messrs. Sutton that they bought up the entire stock intended for England and introduced it into that country in 1881.

Soon after the introduction of Empress of India, came A 1, May Queen, and Harbinger (all being the result of crossing American Wonder with Paragon), and it is interesting to observe that, although these experiments were carried out before the results obtained by Mendel were brought to public notice, it was found necessary, in order to secure fixed stocks, to grow from single plants only—the reason, however, not being so apparent as at the present time.

As time went on seedlings from the crosses were themselves used as parental forms, as also was Gradus (a variety introduced by Laxton and said to be a cross between Earliest of All and Duke of Albany), until, by crossing and recrossing, it has been possible to put into commerce such varieties as First of All, World's Record (both results from Harbinger × Gradus), Ideal (A 1 × Chelsea Gem), Reading Wonder (Harbinger × Gradus), and others, all of which retain not only the large size of pod and delicious flavor of the marrowfats, but have the earliness of the older round-seeded kinds, and in several instances even the earliness of the latter has been eclipsed.

The following table gives the dates on which pods of the parental forms and the seedlings could be gathered, all having been sown on the same day and treated alike:

Parental forms:	
Earliest of All (round-seeded)	June 15
Early Champion (round-seeded)	June 15
American Wonder (wrinkled)	June 18
Gradus (wrinkled)	June 19
Chelsea Gem (wrinkled)	June 20
Duke of Albany (wrinkled)	June 26
Telephone (wrinkled)	June 27
Champion of England (wrinkled)	July 7
Paragon (not now often grown; was a second-early wrinkled pea).	
Seedlings:	
Empress of India (wrinkled)	June 16
A1 (wrinkled)	June 17
May Queen	June 12
Harbinger (wrinkled)	June 15
First of All (wrinkled)	June 13
World's Record (wrinkled)	June 13
Ideal (wrinkled)	June 14
Reading Wonder (wrinkled)	June 15

The late Dr. Maxwell T. Masters, F.R.S., after an inspection of some hundreds of rows of these experiments, wrote in the *Gardener's Chronicle:* "They are very interesting as showing what may be done by crossbreeding and selection when these processes are carried out not haphazard, but with a definite aim in view."

EDITORIALS

THE WOMAN MOVEMENT AND EUGENICS

The world-wide impulse on the part of women to desire the right of suffrage is but a part of the evolution in the adjustment of women in the vocations. Machinery has taken much of women's work out of the home and placed it in the shop and the store. Public education has taken another part into the school. Machinery, improved transportation and other agencies have reduced the number of farmers from two-thirds of the whole population to one-third, and many women who directly and indirectly labored in agricultural production are now in city homes or are employed in non-agricultural vocations. The vastly increased number of vocations and the vastly increased number of people in vocations other than farming and household work, due to the evolution of manufacturing methods, transportation and business, have given openings to women in a multitude of new lines of work. In nearly all cases the work is for wages or salary. Very few women, comparatively, are managers of businesses of their own. And relatively few have professional work of an independent nature.

With the rapid increase of wealth a large number of women of well-to-do families go into the leisure class, producing, often, neither children nor other forms of national wealth. But the great change has been from work in the home, usually the farm home, to work as an employee.

On the whole, women are becoming much more independent of fathers or husbands for support; and in a very large proportion of cases their labor goes to the support of the family, as was the case when women did part of the productive work of the farm. On the whole, the family income is greatly augmented, and the food, the clothing, the housing, the schooling, enjoyable reading matter, and pleasurable social intercourse are greatly increased. The hours are shortened; the physical overstress is greatly relieved; but on the other hand, indoor occupations greatly lessen muscular vigor and doubtless impair genetic vitality.

The new order of things has thrown women more on their own resources and more together. The shop, the store, the school, and especially the wider social life have proven a suitable soil in which to grow up a community of interests. Such discriminations as a lower scale of wage for the same service as given to men, the prohibition of the

right of the ballot, the ownership of too large a proportion of the property by men and unequal rights at law, together with a growing feeling that motherhood is worthy larger rewards, have been the fertilizing elements which are giving growth to the woman movement. It is a part of organic evolution; a centering, a coalescing, a correlating, a coördinating of a very material force heretofore not acting with unity. Its size and importance is comparable with that of the financial interests, the labor unions, the federations of farmers. It is withal wholesome and is destined to succeed in gaining very large results.

Contemporaneous with this stupendous economic, educational, social, and political movement of women is a very strong tendency to reduction of the birth rate; though this is in part counteracted by a lessened infant mortality and by general sanitary conditions and methods which materially prolong the average of human life. The age at marriage is increased; the stress of high living seems to make necessary the absence of very many women from the home so as to help secure adequate family incomes; women work at occupations which soften their muscles and cause them to shrink from childbirth and from the manual labor of caring for children. And those with splendid eugenic heredity, possibly even more than those whose children will fall below average efficiency, use their knowledge to lessen the birthrate.

The ideals of our times—too often promulgated by our schools—which should serve future generations as well as the present generations, have led our women to disregard to too great an extent social values, racial duties, and racial opportunities. Our leaders have been narrow in not teaching women more of the wholesome, vital, and racial points of view of motherhood. Very many women of the very best racial blood have chosen to belong to the girl bachelor class. The philosophy of our times has rather encouraged bright women to choose a successful line of employment, or to repose in the "fine art of idleness" in parental homes, or to lead lives of married sterility. Those able financially, physically, and morally to produce the best children so as to bring up the racial average have been rather content that their sisters with less of material wealth, often not strong physically, and sometimes with lower moral ideals should produce a larger percentage of youth. It would seem that the relatively lower birthrate in the families of the more effective persons, as compared with the higher birthrate of those whose average efficiency is lower than the normal, is on the whole carrying the network of descent, of the nation as a whole, to lower rather than to higher levels.

Possibly it is natural that women should magnify the rights and the opportunities of the individual in the present state of social organization. It must be recognized that they are magnifying the home as never before, especially the physical and mental phases of the home. [Whether, even in the presence of greatly enlarged education and with vastly more, better, and cheaper books they are building up the moral and spiritual aspects of home life is widely questioned.] They are also taking a far more active part in making the community, the county, the state, and the nation of service to the home. Their movement for suffrage is in no small part a step preliminary to the closer control or perhaps even elimination of the saloon, and the brothel, and even looks toward measures to bring about the abolishment of wars, three great enemies of home and happiness.

The woman movement is marked by great epochal campaigns. Her right to labor in any suitable vocation is nearly won in this country. Among the many other movements that of the eugenic possibilities, opportunities, and responsibilities of motherhood has arisen. It is as yet but poorly defined. No one has as yet become its acknowledged leader, nor has any one defined its principal factors. These are being defined by the modern science of genetics. The breeders of plants and animals, the students of heredity, and those who have made the beginnings of the science of eugenics, the breeding of men, have wrought out many of the scientific facts and a few of the practical factors.

In the large, the problem is so to organize the ideals of people and the economics of the country and the world that the blood with highest eugenic efficiency will become dominant; that the blood with medium value shall be less rapidly multiplied, and that which is least efficient, shall reproduce less freely or not at all. This means that records of the efficiency of all individuals must be kept, and that these records must be compiled into performance pedigrees showing average eugenic values of the members of families, upon which may, with reasonable certainty, be predicated the average probable value of the progeny of each person.

These records will be neither costly nor difficult to make as compared with the value of even small improvements in the heredity of the world's paramount species. The breeders of plants and animals can help formulate practical plans for recording eugenic data and for tabulating and interpreting them. And ere long our most skilled genetists will be among those who seek methods of improving this most complex and immeasurably the most interesting species.

And once our women shall have gotten past the present foibles

of eugenics and have guided themselves into sane, scientific, and practical lines, they will formulate the largest of all their campaigns. The women will add eugenic science as the largest new addition to their religio-science teaching. And the families of men will come to estimate values in terms of efficiency of grand-children, multiplied into the number in the grand-fraternity group. Then on the one hand eugenic improvements and on the other hand education and other environmental improvements will proceed together in the development of a race of high average sanity, health, and general efficiency.

BREEDING AND AGRICULTURAL ORGANIZATIONS

At the end of the twentieth century, speaking broadly, the United States will have approximately fifty million farm people, who will have the task of growing food for other one hundred fifty million people living in towns and cities or two hundred million all told. About fifty million farmers will be organized into ten million families for the most part on ten million family owned farms.

On the average, about a thousand people living on an area of perhaps 20 to 40 square miles, and comprising about 200 farm families, will be organized into a consolidated school district, each farm sending to school an average of one pupil, these institutions will have each about two hundred pupils. These school districts will eventually serve also as convenient districts in which to organize every variety of country life collective activity, mostly on a coöperative basis. Thus, we will have somewhere near forty thousand country life schools. Each one of these will have a school farm of ten acres to be used in large part in instruction, and in testing new varieties of plants. A county of average size will contain about twenty of these country life school units, organized into a county country life school system.

Ten counties, with two hundred country life school districts, in a number of States constitute a State technological agricultural high school and branch experiment station district. Each of the four hundred of these State technological farmer's schools and stations will, on the average, have five hundred acres of land, or a total of two hundred thousand acres. On its large school farm each agricultural high school will have approximately four hundred students, requiring an annual public expenditure of perhaps thirty or forty thousand dollars, and a branch experiment station with an annual expenditure of ten thousand dollars.

Eight technological school and branch agricultural station districts, in a large state on the average, would constitute a state district

country life school system, articulating with and supplementing the state agricultural college, the State Experiment Station and the State normal school. The State Colleges and the State Experiment Stations will have farms averaging one thousand acres or a total for the United States, of fifty thousand acres.

The fifty State Colleges and Stations will supplement the U. S. Department of Agriculture; whose separate experiment station farms, demonstration farms, forest nurseries, plant introduction gardens and temporary experimental tracts will cover another fifty thousand acres.

Thus 500,000 acres belonging to country life schools, 200,000 to State technological agricultural schools and branch experiment station farms; 50,000 to State Agricultural Colleges and State Station farms; and 50,000 used by the U. S. Department of Agriculture makes an aggregate of 800,000 acres devoted to agricultural research and country life education.

It is not too much to hope that 200,000 acres or one-fourth of this 800,000, will be demanded by public work in breeding plants and animals. And certainly several times this amount of land will be required under private efforts at creative work in plant and animal breeding.

In many species of plants the experts at breeding will coöperate with the superintendents of all three classes of public farms and with many private breeders and plant growers. Whether they be officers of the U. S. Department of Agriculture, of a State Experiment Station or of a branch station, they will be able to coöperate with many stations in testing new introductions or creations and in adjusting them to their proper zonal areas of country in which they will be of service to the farmers. The branch stations and the consolidated rural school farms will offer the large aggregate of opportunity to adjust varieties to the localities where they will be especially useful. The federal and state experiment stations will be able to highly develop methods of breeding in both plants and animals, and will have the means with which to assemble and test the necessary foundation stocks. They will also best be able to develop men highly trained in hybridizing, in seeking out mutations of value, and in building up such recombined networks of descent as will form varieties which prove of highest value to growers of plant and live stock products.

If the Department of Agriculture would expend $2,000,000 annually; the State Experiment Stations $2,000,000; the branch stations $2,500 each, or a total of $1,000,000; and the consolidated rural schools $50 each, or a total of $3,000,000 annually, a grand total of $8,000,000

in breeding and testing plants and animals, and the result would be $200,000,000 increase in our farm products, the national and state governments would thus increase production equal to one-tenth of our total national, state, municipal, county and township public expenditures, each dollar producing twenty-five dollars.

As the man whose fields yielded sixty bushels of wheat groaned because "It is mighty exhausting on the soil," so these figures seem large to the conservative man, who hesitates about making expenditures and groans over public expenditures designed to produce wealth as well as those designed to make war or to pay pensions.

If our plant varieties and animal breeds do contain mutations of large value, as scientists have proven, the work of segregating them and replacing the less valuable forms with new varieties and breeds which have the power to produce ten or twenty-five per cent additional farm products, is one of the largest of our conservation problems. Shall the views of the pessimist and the ultra-conservative prevail, or shall we gradually, and more rapidly, develop plans for using part of the available public experiment and demonstration farms for breeding superior types of plants and animals? If this work is to be undertaken for the whole United States, federal and state plans fitted to the whole area are neither too small nor too large for the project.

RACE GENETICS PROBLEMS

If the amount of space which is devoted to questions of the day in books, and in technical and popular magazines be accepted as a criterion of the importance of any particular subject, eugenics is slowly but certainly approaching the discussion stage; a circumstance of immense importance. And indications are not wanting that the race-social and race-hygienic questions which are being agitated by various reform elements are excellently preparing the ground for the further favorable reception of eugenics as a practical science—a science which comprehends not only the individual and the family, but the entire race.

The fundamental ideas of the application of the same laws of heredity to all living matter, plant, animal or man alike, and of the hereditary transmission of certain traits for good or evil are being received more readily among the intelligent and thinking part of the population, than the pioneer eugenists in their fondest hopes have allowed themselves to believe possible. It appears not at all improbable, nor even visionary, that in fifty or seventy-five years negative eugenics will have gotten a sufficient foothold in race-proud families, in the

statutes of states, and in practical Christianity to have brought under a reasonable degree of control the honey-combing attacks of tuberculosis, neurasthenia, syphilis, and alcoholism, and that small portion, a nucleus, of the white race at any rate, will voluntarily have placed itself under a positive eugenic regimen.

Part of, and most intimately connected with eugenics is the problem of (human) race biology, which in itself covers a field of research of vast extent. The mingling of races, brought about by the white man's own aggressiveness, inventiveness, and desire of conquest and dominion, is reacting somewhat against him. At no time in the world's history has there been in progress such a general mingling of the races of the human breed, over so vast an area, as at present. And it is not a mere over-lapping of nationalities along the border lines of their respective countries, or a matter of one race possessing itself of territory occupied by another, driving it before as it were, each race retaining in the main its pure characteristics. Modern transportation facilities, capable of transplanting in a comparatively short time entire sections of population of one country to another country facilitate race mingling on a stupendous scale.

Speaking especially with reference to the United States, although applicable also to Canada, we have in most unjustifiable and unscientific fashion been assuming that in this great "melting pot" the best qualities of all nations and all races are being run into one great flux from which there would be cast one superior individual—a superman —the American. With optimistic forgetfulness we failed to take into account what was to become of whatever bad qualities there were. Truth is that up to the present, race mixture in its strictest sense had not been taking place. It was negligible because infinitesimally small, and the "American" of today as we have him in mind, is really the result of the unfoldment of the pronounced, inherent, initiative, creative, and constructive traits of the long-light, blond, long-skulled race, under the environments of a new continent with untouched resources, a new soil, favorable climatic and physical conditions. The political, commercial and industrial ventures of this race do not owe their unparalleled successes to a supposed blood mixture, but to qualities acquired and bred into its protoplasm since the stone age. That same race had in earlier periods built up marvelous culture centers in Egypt, India, Greece and Rome. So long as we were compounding English, Celt, Scandinavian, German and Dutch we were merely mingling and regenerating a practically homozygous stock of aryo-germans.

As yet we have too small a scientific basis to make pronounciamen-

tos as to the beneficial effects of indiscriminate race mixture, or, for that matter, of the superiority of pure racial stocks, or of the value of the mixtures of specific races. Together with eugenic research within the species, must proceed research into the origin, inherent peculiarities and genetic and social values of the different racial stocks, and the results of each of the possible crosses. We are allowing race mixture to proceed on a large scale without definitely knowing, for instance, which characteristics of the white, the yellow, and the black breeds are dominant; without having a knowledge of whether certain undesirable physical and psychic characters of other races are not so strongly dominant as to breed out some of the most desirable and distinctive characteristics of the aryo-german race; whether we are breeding to build up or to undermine our own civilization; whether the aryo-germanic race, which took possession of this continent, assumed dominion over it and planted in it its civilization, institutions and ideals, is not in danger of being mixed with the blood of other races to the degree of obliteration if the present rate of influx of immigration from the far east, from southern and southeastern Europe and from Asia Minor is allowed to go on unchecked.

Assimilation has been used as a word to conjure with. But in view of the fact that heretofore we have really been "assimilating" races of kin we do not know the precise assimilative strength of aryo-germanic blood. The long-skulled, (dolicocephalic), blond, blue-eyed race is meeting with a tremendous influx of the round-skulled (brachycephalic), generally black-haired and black-eyed race. The final test, which is inevitably approaching, will not consist in assimilating this or that other race but in dominating the complicated network of heredity in what threatens to become a blood-chaos.

The Slavs, the eastern branch of the aryo-germanic race, inhabiting what today is Russia, were by origin long-skulled, blue-eyed and blond-haired. Repeated Mongolian invasions have left their inevitable marks and have changed them to predominatingly round-skulls. This much for assimilation.

The sub-races of the aryo-germans which all through history have proved to be carriers of culture and civilization can assure themselves of the continuance of their dominance in world's affairs, and of the permanence and even brilliant expansion of the splendid civilization they have created, by scientifically directing their evolution. A sound eugenic sentiment, backed by race pride and family pride, will be the vital power which will direct that race toward the larger ends. All other races knowing their genetic values can similarly strive for eugenic results, encourage fit and discourage unfit crosses.

NEWS AND NOTES

ZEBU CATTLE RESISTANT TO TEXAS FEVER

The Twenty-sixth Annual Report of the Bureau of Animal Industry, recently issued, contains the following relative to the immunity of zebu cattle:

About thirty years ago a number of the so-called Brahman cattle of India were introduced into southern Texas by A. H. Pierce, a stockman of Pierce, Texas. These animals were crossed with our domestic cattle, and the resulting influence on the herds was markedly apparent. One of the most interesting observations was that their progeny remained relatively free from ticks while other stock in the same pasture would be literally covered with these pests. The cattle ticks are present in such enormous quantities in this section of Texas as to make cattle raising much less profitable than it should be. This is due not so much to the fact that these ticks carry the Texas-fever microorganism as to their great blood-sucking powers as external parasites. The Brahman grade cattle appear likewise to be less affected by other parasites and pestiferous insects such as mosquitoes, hornflies, gadflies, etc., and to withstand better the warm, dry climate and other semitropical conditions present in the Gulf Coast section of the United States than do the native cattle. * * *

The sebum secreted by the sebaceous glands of the skin has a peculiar odor which seems to be repugnant to insect life. The hide, while it may be as thin as in our domestic animals, still appears to be much tougher and is more difficult to penetrate with a hypodermic needle. The hair is quite short and does not provide favorable shelter for the development of ticks. These three factors are probably responsible for the slight amount of tick molestation which these animals experience.

Dr. Farrington, assistant chief of that bureau, in commenting on that statement, says:

It has recently been reported to this office that the descendants of the 1906 importation have proved, and are proving, fully as resistant to the Texas fever ticks as the members of the earlier importations, and in consequence acquire a larger growth, and are always in superior condition and thrift.

There were 33 animals in the importation of 1906, and at the present time half-blood and three-quarter-blood descendants in large numbers have been carefully observed, and all have proved very satisfactory in their resistance to infection with Texas fever.

Mr. A. P. Borden, of Pierce, Texas, the leading authority on these importations, says that every year proves more conclusively the desirability of crosses between the cattle of India and our common cattle from west Europe as producers of live-stock products in Texas and the Southwest generally.

ORGANIZATION OF A FRUIT REGISTRY ASSOCIATION

An organization known as the American Fruit Registry Association has been established with headquarters at Sunnyside, Washington, Mr. H. M. Lichty, secretary. The purpose of this organization is to secure scions from mother trees of the different varieties of fruit which by actual test are known to have been prolific yielders. This association makes the assumption that there is sufficient bud variation among the trees of a given variety of apple, for example, to make profitable a selection of scions from the few very prolific trees. So far as we know, this is the first time such an assumption has been put into commercial use by an association.

It may be that bud variation does occasionally occur in a way sufficiently marked to justify making of it a material commercial factor. In other words, there may be an occasional mother tree from a bud which, like the mutating seedling plant, has a combination of characters of value peculiarly higher than its fellow trees.

In any event, this association will be able thus to secure wholesome scions and stronger trees. If persisted in, this plan should soon develop whether there is an occasional mutating mother plant from which cuttings can be secured which in turn will produce trees higher in value than the average of the variety.

An effort should be made by the scientists who are studying practical methods of breeding to collect and collate the data which will become available from the work of this association. Selection made in the manner proposed would have been looked upon several years ago as practically ineffective or it would have been held that the selection is in so narrow a range that improvements would not be sufficient to cover the expense.

This company has got out a scheme of blanks and certificates under which they give a sort of pedigree certificate of stocks from mother trees. Should the fondest hopes of these people be realized they will probably be able to give to scions from stock which proves heavy-bearing some form of advanced registration status, as is now done in stock breeding.

THE SUGAR-BEET INDUSTRY IS BASED ON BREEDING

Perhaps the most striking instance of a great industry resulting from the efforts of the plant breeder is afforded by the sugar-beet industry.

Vilmorin and other early plant breeders in France took the common beet and through breeding and selection succeeded in increasing its percentage of sugar from 6 or 8 per cent to 12, 15, or even 20. But alongside of its composition in sugar content they also developed the crop yield so that the yield per acre of sugar was sufficiently large to make the production of sugar by means of this plant profitable.

According to preliminary census returns, there were produced in the United States, in the calendar year 1909, 1,003,400,000 pounds of beet sugar, worth at wholesale $45,938,000. According to commercial estimates there were produced in Europe and other countries, in the crop year 1909–10, 13,532,000,000 pounds of beet sugar, a total of 14,535,400,000 pounds. The magnitude of the beet-sugar industry is indicated by a comparison of the beet-sugar output with the total sugar produced in the world from other sources, as follows: There were produced in the United States in the calendar year 1909, of cane sugar, 668,200,000 pounds, according to preliminary census returns, and in the crop year 1909–10, for the rest of the world, 17,823,000,000 pounds, according to commercial estimates. There was in addition produced in the United States, of maple sugar, 11,928,770 pounds in 1909. Thus, beet sugar constituted 60 per cent of the crop in the United States in 1909 and about 43 per cent of the sugar crop of the rest of the world in 1910–11.

From the agricultural standpoint, beet-sugar growing has the additional value of inducing intensive cultivation and of getting the land in good tilth for other crops.

A VARIETY OF CORN BRED SPECIALLY FOR ELEVATED REGIONS

Mr. A. Jay Garrison, member of the American Breeders Association, of Edgewater, Colorado, has been for many years an outdoor student of the science of breeding as applied to both plants and animals. He is a very successful breeder of poultry with respect to quality, and as a plant breeder he has originated a number of valuable plums.

The corn shown in the photograph is the result of three crosses in six years, starting with Cory sweet corn and a local semi-dent, low-growing variety known as Pike's Peak. The result of each cross was bred back to the Pike's Peak to preserve and intensify the low-growing habit of this strain. And the constant tendency from this breeding has been for the ears to appear lower on the stalks, a necessary

characteristic of corn to be grown in a dry and elevated region. Another tendency was the increasing percentage of stalks bearing two ears to the stalk.

The original ears of Cory and Pike's Peak averaged 6 inches in length. The average length of the ears of the first cross was 8 inches, and that of the two ears shown is 12 inches and 11, respectively. The length of the stalk is 55 inches.

The seed was planted June 10, and the corn was cut September 9. The season was unusually dry and irrigation water scarce, and this corn was grown without irrigation or cultivation.

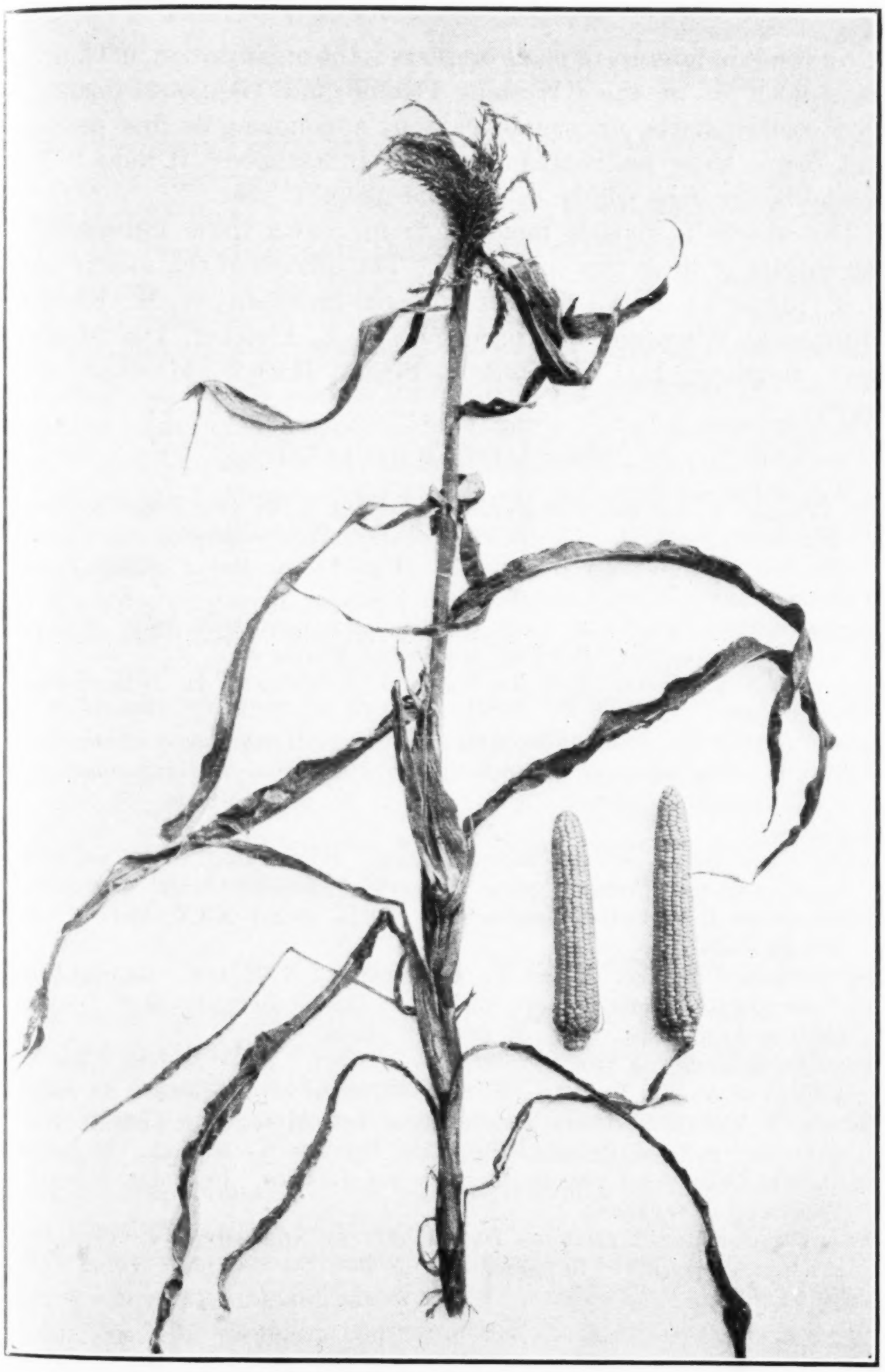
The variety promises to be of great value for dry and elevated regions like that in the vicinity of Denver.—LEVI CHUBBUCK, *Denver, Colo.*

A EUROPEAN ESTIMATE OF THE AMERICAN BREEDERS ASSOCIATION

In an address delivered in Vienna, Austria, before the Society for the Diffusion of Knowledge in the Natural Sciences, Professor Dr. Erich von Tschermak reviewed the "Experimental Work in Modern Problems of Heredity as Carried on in North America."

The work of Castle, Morgan, Davenport, Tower, Shull, MacDougal, Webber, Williams, Hansen, Burbank and others is mentioned in connection with the work each of these men have done. At the close of this address, Dr. von. Tschermak pays to American breeders a tribute which is as generous in spirit, as it is surprising in frankness. Coming from a European scientist of note his remarks are significant and it should be gratifying to every member of the American Breeders Association to be affiliated with an organization which has been instrumental in advancing genetics in its every phase. He said: "The picture which I have here hastily sketched shows a truly astonishing developemnt of this modern science of genetics, in North America. With youthful energy, which perhaps at times had a too narrow specialism, American researchers have accomplished much that is highly to be commended in science.

In order to hold even honors in future with the scientific accomplishments of her American sister, our European biological science must follow her progress with attentive care and strive for the possession of similar generous equipments for research. Experimental biology has actually, in part, become an American science. Europe must put forth most strenuous efforts not to be completely distanced."



A CORN BRED FOR ELEVATED REGIONS.

A DAHLIA AND GLADIOLUS SOCIETY ORGANIZED

An event of interest to plant breeders is the organization, in Chicago on August 5, of the "Western Dahlia and Gladiolus Society." This society starts out energetically by announcing its first meeting and flower show on September 26 in Indianapolis, Indiana. The second flower show will be held in Chicago next year.

The society is inviting members from among those interested in the culture of these two specialties. The officers of the society are: E. T. Burns, (A. B. A.) Spencer, Indiana, president; W. W. Kauner, Milwaukee, Wisconsin, vice president; W. K. Fletcher, Des Moines, Iowa, treasurer; E. C. Thompson, Benton Harbor, Michigan, secretary.

PUBLICATIONS RECEIVED

DIE PRÄRIEN IN ZENTRALNORDAMERICA UND IHR WERT FÜR FORST KULTUR. Dissertation prepared for degree of doctor of philosophy at the Ludwig Maximilian University in Munich. Hugh Potter Baker (A.B.A.). 10 illustrations.

PROCEEDINGS OF THE SOCIETY FOR HORTICULTURAL SCIENCE, 1910. Seventh Annual Meeting. C. P. Close, secretary. 89 pages.

KREUTZUNGSUNTERSUCHUNGEN AN HAFER UND WEIZEN. H. Nilsson-Ehle. Lund, 1909. 122 pages.

UEBER FALLE SPONTANEN WEGFALLENS EINES HEMMUNGSFAKTORS BEIM HAFER. Reprint from Zeitschrift für Induktive Abstammungs- und Vererbungslehre. 1911. Vol. V, Heft I. H. Nilsson-Ehle. 37 pages, 2 plates.

UEBER ENTSTEHUNG SCHARF ABWEICHENDER MERKMALE AUS KREUZUNG GLEICHARTIGER FORMEN BEIM WEIZEN. Reprint from Bericheder Deutscher Botanischen Gesellschaft. 1911. Band XXX, Heft 2. H. Nilsson-Ehle. Pp. 56–69.

THE OSTRICH INDUSTRY IN THE UNITED STATES. A. R. Lee. Reprint from Twenty-sixth Annual Report, Bureau of Animal Industry, U. S. Department of Agriculture, 1909. 12 pages, 3 plates.

BREEDING HORSES FOR THE UNITED STATES ARMY. A. D. Melvin, Chief of Bureau of Animal Industry, U. S. Department of Agriculture, 13 pages.

UEBER DIE EXPERIMENTELLE BEARBEITING DER MODERNEN VERERBUNGSFRAUGEN IN NORDAMERIKA. Prof. Dr. Erich v. Tschermak. 26 pages.

UEBER DIE VERERBUNG DER BLUETEZEIT BIE ERBSEN. Prof. Dr. Erich v. Tschermak. 24 pages.

BEWERTUNG DER ZWEIZEILINGEN BRAUGERSTE IN NORDAMERIKA. Prof. Dr. Erich v. Tschermak. 10 pages.

ASSOCIATION MATTERS

YEARBOOK OF PROCEEDINGS OF THE "A. B. A." FOR SALE

The Secretary's office has on hand a number of copies of Volumes IV and VI which as customary, will be sold at $2 per volume. Back numbers of Volume I of the *Magazine* will be furnished with Volume VI of the Proceedings until the supply is exhausted.

The members of the Association are requested to assist the Secretary in selling some 500 copies of Volume VI. The Association has considerable funds tied up in these yearbooks and it is desirable to realize on at least part of them. A liberal allowance has been set aside to meet possible demands from newly entering members, leaving several hundred for sale to individuals, libraries and institutions. Members are requested to do some lively and energetic work in placing these publications in public libraries, and those of colleges and universities.

If only a very small fraction of the 30,000 public libraries regularly carried our publications on their shelves the four or five hundred copies which we can spare would soon be disposed of.

It should certainly be an easy matter to induce your local public library to purchase these Proceedings regularly. Besides this, we would gain another object, namely, that the propaganda of the American Breeders Association would be brought more fully before the public, and our publications would do the missionary work which in part they are designed to do.

NEED OF GREATER PUBLICITY

One of the pressing needs of the Association is publicity. It is needed to attract new members. The Association must be kept in a state of expansion and vigorous growth.

Publicity is also needed in order to make the propaganda of the Association fully effective. We know that what we advocate regarding the improvement of the plant and animal resources of the world by breeding is sincere and sane, and we should let the world know it. We know that our advocacy of eugenics research and of a eugenics program is rational and sound, and we should therefore place ourselves in a position where we can command the attention of the thinking part of the population of this and other countries. The American Breeders Association can be made to be widely known if its members

will frequently, persistently, systematically, and on every possible occasion mention its objects, its work, and its publications in the circle of friends, in the lecture room, or in public meetings, and in the press.

REPORT OF THE SECRETARY OF THE COLORADO STATE CHAPTER

During the early part of the present year several of the Colorado members had some conversation regarding ways and means of promoting the interests of the plant and animal breeder, and at this conference it was suggested that something might be gained by organizing a state chapter or section for the purpose of getting the Colorado members together at two or perhaps more meetings during the year. At these sessions special problems relating to the improvement of fruits, farm crops, or live stock could be discussed and it was thought that in this manner our members would get better acquainted with the development of different phases of this subject in the West. This in turn would lead to a more careful study of the plans which have been evolved in other sections of the country under the direction of the parent organization.

On February 22, a meeting was therefore held at which twenty-one men were in attendance. The plan in question met with hearty approval from every member present, and a committee of three was appointed to draft a constitution for the guidance of the proposed new chapter. Several of these men were not members of the American Breeders Association, but when the objects of the society were explained a number immediately requested that their names be placed on the membership list of the national organization and promised that they would lend their assistance in promoting the welfare of the local chapter. This attempt to get our men together has resulted in additions to the American Breeders Association, and we have every reason to believe that many more names will be sent in before the end of the year.

Our second meeting was held on the evening of July 3. The entire time was spent in discussing the constitution which was prepared by the committee. During the busy summer season it was not possible for us to plan for another session, but we hope to be able to report rousing meetings early in the autumn and winter months.—L. A. MOORHOUSE, *Secretary, Colorado Chapter, A. B. A.*

EIGHTH ANNUAL MEETING
1911-12
AMERICAN BREEDERS ASSOCIATION

WASHINGTON, D. C.

December 28–29–30

At the new Masonic Temple, corner 13th Street and New York Avenue, N.W. General sessions 11:00 to 12:30 daily, and 8:00 to 10:00 p.m. on December 28 and 29.

Plant Section meetings, Assembly Hall, 9:00 to 11:00 a.m. and 2:00 to 4:30 p.m. daily.

Animal Section meetings, North Hall, 9:00 to 11:00 a.m. and 2:00 to 4:30 p.m. daily.

Eugenics Section meetings part in South Hall, part in St. Elizabeth's Insane Hospital and part at the Volta Bureau, 35th Street and Volta Place, Georgetown. For further data see final program.

Hotel headquarters; room 214 Raleigh Hotel. Single rooms $2.00 a day and up; single rooms with bath, $3.00 a day and up. Double rooms, $3.00 a day and up; double rooms with bath, $4.00 a day and up. *Rooms should be reserved at once.*

Please send titles of papers before December 10 either to the section secretaries (H. J. Webber, Plant Section, Ithaca, New York; C. B. Davenport, Eugenics Section, Cold Spring Harbor, New York; H. W. Mumford, Animal Section, Urbana, Ill.), or for general committees, to the Secretary of the Association, W. M. Hays, Washington, D. C.

Railroad rates: In paying your fare to Washington, request a certificate. If the station agent has no blank certificate, buy ticket to nearest town where certificate can be secured and then buy ticket and secure certificate. On arriving in Washington, present your certificates to Mr. F. S. Hazzard, assistant secretary of the American Association for the Advancement of Science, office of permanent secretary, New Willard Hotel. Write Mr. F. S. Hazzard, Smithsonian Institution, Washington, D. C., for more detailed information concerning transportation and for lists of more than thirty affiliated societies which meet in Washington during holiday week.

For program and other information concerning the American Breeders' Association, write to W. M. Hays, secretary, Washington, D. C.

ALBRECHT DANIEL THAER